501
Mur/Hab
59863

Digitized with financial assistance from
Government of Maharashtra
on 30 January, 2020

HABIT AND INTELLIGENCE.

HABIT AND INTELLIGENCE,

IN THEIR CONNEXION

WITH THE LAWS OF MATTER AND FORCE:

A SERIES OF SCIENTIFIC ESSAYS.

BY

JOSEPH JOHN MURPHY.

59863
oe

IN TWO VOLUMES.

VOL. II.

London:
MACMILLAN AND CO.
1869.

[*The Right of Translation and Reproduction is reserved.*]

LONDON:
R. CLAY, SONS, AND TAYLOR, PRINTERS,
BREAD STREET HILL.

00059863

CONTENTS OF VOL. II.

CHAPTER XXVII.

INTELLIGENCE.

Formative, motor, and mental functions, all guided by intelligence—Instinctive intelligence of the bee the same in kind with formative intelligence—Instinct is not more wonderful than formative intelligence—Purpose in the formation and action of the iris—Gradation from unconscious to conscious and rational motor actions in the eye, and in the digestive organs—Actions determined by sensation—All motor actions are intelligent, whether conscious or not—Intelligence, unconscious and conscious, formative and mental, is fundamentally the same—This view includes instinct—We cannot point out the beginning of sensation, or of consciousness—Most thought, perhaps all, is partly unconscious—Identity of formative, instinctive, and mental intelligence—A special act of creation is not necessary for every new adaptation—Moral difficulties lessened by this view—Parasitic worms—Unnatural or immoral instincts—All matter is endowed with forces, and vitalized matter is endowed with intelligence—Intelligence tends to guide all vital actions in the direction that is best for the health of the organism—Disease is no exception—Vital actions minister not only to the individual, but to the race—Reproductive and maternal functions—Social affections—Development of unconscious action into conscious—Love of life.

NOTE: *Instinct*:—Instincts of social insects cannot be inherited—Darwin's explanation by natural selection—I think them due to Intelligence—Instincts of some fishes . . . . . Pp. 1—11

CHAPTER XXVIII.

MIND.

Definition impossible—Mind is developed out of sensation—Consciousness inexplicable—Consciousness is of sensation—Sensation without consciousness—Sleep—Mental development—Consciousness distinct from sensation—Acquired taste due to a change not in the sensation, but in the consciousness of it—

Analogous impressions from different senses—Consciousness is indivisible—Biological ground of this in nervous centralization—Sensation is divisible: consciousness not—Consciousness not hereditary—Instance: how birds acquire a dread of man . . . . . Pp. 12—17

CHAPTER XXIX.

THE PHYSIOLOGY OF MIND.

Differentiation into organs of vegetative and of animal life—Contractility the fundamental character of the latter—Nervous system developed out of muscular—Its primary function is to transmit stimuli to the muscles—Nervous system never simple—Ganglia—Reflex action—Nervous function differentiated from muscular function—Sensation does not exist at first—It begins probably with special sense—Sentient and insentient nerves histologically alike—Parallel development of organs and of functions—Corpora striata: their relation to the sensory ganglia—Consensual action: its similarity to merely reflex action—Sensation at first is only the guide to action—Insects have only this, with some possible exceptions—Sensory ganglia developed out of spinal cord, and cerebrum out of sensory ganglia—The cerebrum is the organ of consciousness—Largest in the highest animals—Cerebrum not in direct connexion with the organs of external life—Its structure—The functions of its parts can be ascertained only by analogy—Phrenological theory disproved by facts—One nervous current producing another—Consciousness is thus produced—Nerves and nerve-currents of consciousness—Is consciousness produced in the sensory ganglia or the cerebrum?—Consciousness of thought is distinct from thought—Unconscious thought—Recollection without apparent cause—Nerves of thought—The sensory ganglia are the seat of consciousness—Consciousness of thought: how produced—Seat of consciousness—Memory—Its rudimentary form is a consciousness of sensation outlasting the sensation—Recollection due to the reproduction of a current of consciousness—Consensual action produced by remembered consciousness—Voluntary action—The same action may be at one time consensual, at another voluntary, according to the nature of the stimulus—Thought acts on the motor ganglia through the nerves of will—Position of the nerves of will—Voluntary actions may become consensual—Instance of a musician—This may become hereditary in animals, as in birds, and in dogs—This explanation will not apply to all consensual actions—Instance of the bee—Voluntary action has been developed out of consensual, and consensual out of insentient—Summary—Enumeration of mental actions—Mutual relation of the nervous organs of mind—Sensation—Consensual action—Consciousness of sensation—Thought—Consciousness produced by thought—Will—Reverie—Sleep—Dreaming—Somnambulism—Grounds of theory stated—Functions of sensory and motor nerves and ganglia are known—Those of the cerebral nerves may be inferred by analogy—Cerebral nerves of consciousness, of thought, and of will—Three primary mental functions probably corresponding thereto—Nerves of consciousness distinct from those of thought and will—Nerves of consciousness: how identified—Thought is in itself unconscious—Nerves of thought—Nerves

of will—Ideo-motor and voluntary actions: how distinguished—The theory incomplete.

NOTE: *Nervous Currents*:—Consciousness is always a secondary phenomenon—The secondary current is not a continuation of the first—Compared to electric telegraph currents—Nerve-fibres are more than merely conductors. Pp. 18—41

CHAPTER XXX.

CONSCIOUSNESS AND THOUGHT.

Physiology is useless as a guide in any but elementary psychology, though all mind depends on nervous action—Proofs of this—Feeling is wider than consciousness—Feelings of sensation and feelings of consciousness—Gradations of consciousness—Emotions—Feeling is inexplicable—Thought is explicable—It begins with the sense of the relation of sensations to each other—Attention to one particular sensation, or to one particular relation between sensations—Instance in geometrical study—We have no real consciousness of *relations*, only of *related things*—But we have knowledge of relations—Unconscious thought thus explained—Thought ceases to be conscious when it is of relations only, to the exclusion of the feelings between which the relations are—What is taken for consciousness of thought is often really consciousness of mental effort. Pp. 42—47

CHAPTER XXXI.

MENTAL HABIT.

All actions tend to become habitual—Motor habits—Voluntary actions becoming habitual and consensual—Mental habit, or association of ideas—Impressions on consciousness are either sensory or ideal—Law of association stated—Instance of a man's face and his voice—Groups of sensations—Association by contiguity and by resemblance, both cases of the same principle—Explanation of association by resemblance: it is a case of association by contiguity—The power of cognising resemblance and difference is an ultimate fact—All association depends on habit—Forgetting, a case of loss of habits by disuse—Reappearance of memories supposed to be lost—Association enters into all mental acts—Memory—Acquisition of knowledge—Accurate knowledge—Error—Reverie—Invention—Reasoning—The mind cannot create, but can only combine—Are all mental facts referable to the law of mental habit alone?—Parallel question in biology—I believe in intelligence, in addition to the laws of habit—The question stated: Is intelligence an ultimate fact?—Why I have treated of association so briefly . . . . . Pp. 48—55

CHAPTER XXXII.

THE GROUNDS OF THE MORAL NATURE.

Definition—*Moral* means *emotional*—*Moral* is contrasted with *intellectual*—The root of the moral nature is in the sense of pleasure and pain—Pleasure and pain are inexplicable in themselves, but it may be possible to tell how they arise—Organic intelligence guides all organisms to do what is for their welfare—Sentient organisms are guided to their welfare by sensation—Exceptions—Reason for thinking the law must be general—Desire and fear—Love of life—Sexual, domestic, and social affections: their roots in the organic life—Great changes are injurious, slight ones beneficial: great changes are painful, slight ones agreeable—Application of this principle to beauty—Roots of emotions in the organic life—Emotions generated by association—Association of feelings—Love of money not a primary feeling: may have become hereditary—Emotions have their seat in the nerves of consciousness—Germ of the moral nature in sensation—Prudence—Unselfishness—Holiness—Origin of prudence: of unselfishness: of holiness—The sense of holiness is a case of intelligence.

Pp. 56—64

CHAPTER XXXIII.

MENTAL DEVELOPMENT.

Is sensation mental?—The question is only verbal—Mind begins with sensation—Feelings of sensation and of consciousness, or bodily and mental feelings: their anatomical grounds: no fundamental distinction—Sensation—Consciousness—Thought—Will—Relation of thought and will to the insentient life—Analogy of mental to organic development—Inter-action of functions in mind—Development of thought, feeling, and will—Consensual and voluntary actions—Intermediate class—Sensation and consciousness both inexplicable—Development of memory, from consciousness outlasting sensation—Necessity of this to thought—Hearing words and sentences—Memory is developed by the law of association—Reverie—Recollection, or voluntary memory—Children have memory with little power of recollection—Only what has been attended to can be recollected—Imagination—Continuance of impressions—Memory—Recollection—Imagination—Development of reasoning out of cognition of relations—Elementary relations—Likeness—Succession—Space-relation—Causation—Relations presupposed in association—Perception—Perception may have its seat in the sensory ganglia—Man's superiority in reasoning—Power of directing thought at will—Language—Abstraction—Whately's view on language—Use of words in thought, due to the power of directing thought at will: whence also the power of abstraction—Instance in arithmetic—Voluntary action is always later developed than involuntary—Simple inference and abstract reasoning—Moral nature developed out of the sense of pleasure and pain—Care for

the future—Emotions due to association—Sympathy—Love of beauty, of knowledge, and of holiness—Summary—Tabular statement—Second tabular statement.

NOTE :—There are unconscious sensation and thought—I believe there is no unconscious feeling . . . . . Pp. 65—82

CHAPTER XXXIV.

MENTAL GROWTH.

Analogy between the organism and the mind in development by differentiation—Organic and mental integration—Analogy of organic and mental growth—The organism is constructed out of the food by the organic intelligence : so mind is constructed out of impressions of sense by the mental intelligence—Assimilation and waste both most rapid in youth—Parallel in receiving and forgetting mental impressions—Organic and mental growth both consist in excess of what is received over what is lost—Waste is a condition of organic life : so is forgetting of mental life—If we remembered everything, we could not think—Coalescence of residua by forgetting—What constitutes familiarity—Words must not only suggest their meaning : they must suggest nothing else—The first of these is secured by remembering, the second by forgetting—Summary—Formation of habits of action by the same law—Moral benefit of forgetting—Forgetting is a case of the laws of habit . . . . . Pp. 83—91

CHAPTER XXXV.

THE SENSES.

External senses—That of heat is distinct—The muscular sense belongs to touch—The skin-nerves are nerves of both touch and heat; as are also the nerves of taste ; and these sensations do not combine with each other : but two tastes or smells, when mixed, combine into a resultant of character intermediate between their constituents : so of mixed colours—Orange—White—Sounds do not so combine, but may be discriminated—Reason of this in the constitution of the nerves of hearing—The nerves of smell, sight, and hearing transmit no other sensation—Probable cause of sensations of different kinds being transmitted by the same nerve without combining—Only touch and sight give perception of space—Intellectual senses : touch, sight, and hearing—Reproduction in memory of impressions of sight and hearing—Pleasure due to this—Its moral importance—Cause of this in hereditary habit—Senses of touch and heat—These sensations do not combine—What touch cognises is resistance—Muscular sense—Taste—Smell : its resemblance to taste—Sight, or the sense of colour—Only some luminous undulations produce the sense of light, and these excite various sensations of colour—Sight gives cognition of space—Characters of sight—Of hearing—Semicircular canals give a sense of the direction of sounds—Hearing is unlike the other senses in the power of discriminating simultaneous sounds

—Distribution of the nerves of touch, taste, smell, and sight, to sensitive surfaces—Distribution of the nerves of hearing different—Laws of sonorous vibrations—Period of vibration constant for the same string—Pitch of note constant for the same string—One string may set another vibrating—Action of sound on the nerves of the ear—Tone of sound: how produced—Why do the secondary vibrations, or overtones, combine with the fundamental into a resultant sound?—The combination or distinction may be due to habit—With practice overtones may be distinguished—Sight and hearing are the most intellectual, and the only æsthetic senses—Music produces a more intense feeling than visual beauty, because the ear loses no time in combining impressions.

NOTE A: *Nerves of Special Sensation*:—Opinion of distinct nerves for distinct colours—Reasons against this—No special nerves of taste, nor of heat—The kind of sensation depends not on the nerves, nor on the ganglia, but on the organ of sense—Sensations of light due to pressure, and to an electric current.

NOTE B: *Colours and the Laws of their Combination*:—Difference between sensations of sight and of the other senses—Meaning of *light* and of *radiance*—Heating and chemical effects of radiance—Radiance consists of undulations—Rays of different wave-lengths are mixed together in the sunbeam—Their separation by the prism—The places of brightest light, of greatest heating power, and of greatest chemical power, do not coincide—Different rays have different colours—Succession of colours—Difference of colour is a physiological fact, and analogous not to tone but to pitch in sound—The octave in sound and in colour—The series of colours in the spectrum is circular, and the opposite colours are complementaries—How to combine colours—Whites produced by the combination of different pairs of complementaries are optically different—All colours except white are in the spectrum—Black—Grey—Brown—Result of combining two colours not complementary is to form compound colours visibly like simple ones, but optically different—No distinction of primaries and secondaries in any physical sense, but there may be in a physiological sense—Further mathematical considerations—Wave frequency—A colour and its octave are 360° apart on the circle—We might expect complementaries to be 180° apart—Discrepancy of observation and theory—How accounted for—All the rays are not equally bright to our eyes—Possibility of giving a formula for any tint—Scientific principles of harmonious colouring . . . . . Pp. 92—116

CHAPTER XXXVI.

PERCEPTION.

The problem, how sensations give rise to perceptions—Perception is more than cognition: it is the referring of sensations to their sources, the sources being present in time—A perfectly accurate definition is impossible—Perception is an inference—The same act may be the one or the other, according to circumstances—The subject has been complicated by extraneous questions—Perception and the cognition of space are distinct, but have been confounded—We cognise space before we perceive objects in it—Cognition of two sensations as separated

in space—Cognition of space by the motion of a sensation—In these ways only superficial extension can be cognised—Cognitions of space and of time originate in parallel ways—Perception of objects external to the body is acquired by the motor sense—Summary—Sight, like touch, originally cognises only superficial extension—Perception by sight is an acquired power—Facts confirming these views—Answer to objection—Perceptions due to both touch and sight—Special connexion of these two senses—Cognition of space in three dimensions is due to touch—Additional proof of this—Touch cognises linear magnitudes; sight cognises angular ones; and we think more easily of the former than of the latter—Words denoting the former are common: words denoting the latter are technical—A being with sight only would cognise only angular magnitude—Impressions of the two senses are identified in the mind as the result of habit—Account of the process—Berkeley—Quotation from M'Cosh—Difficulty about instinctive actions, as a duck running to the water when it leaves the egg—Explanation: these are cases of hereditary habit—Presumption that perception is not a simple act, from the multiplicity of senses—Difficulty of the subject from their multiplicity and their combination—Elements involved in perception enumerated—Assignment of a sensation to its source—Cognition of space-relations—Perception of objects in space—Combination of impressions of touch and sight—What is "the external world" external to?—It may be extra-mental, or only extra-organic—No organ of sense can perceive itself.

NOTE:—Case of a being having knowledge of space from sight only—It would cognise only surface, and that the surface of a sphere—It would see straight lines as arcs of great circles—Plane geometry would seem true to it only on infinitely small surfaces—The eye cannot see a plane surface or a straight line—Straight lines are seen as arcs of great circles, which intersect when produced—Reid's "Geometry of Visibles"—A Barrister's puzzle . . . Pp. 117—132

CHAPTER XXXVII.

THE RELATION OF THE MIND TO SPACE AND TIME.

Our knowledge of time is a primary cognition: we cognise time in cognising our sensations as successive—I believe space is cognised in a parallel way—Opinion that space is cognised by motion only—Similarity of space and time—Both are necessary—Magnitude is more naturally expressed in space than in time, though number is expressed in time—Conclusion that the cognitions of the two have separate origin—Is the argument relevant?—Reason for thinking that it is—Larval and mature forms of these cognitions—Reason advanced for thinking that the cognition of space is from motion—Time is more inseparable from our thoughts than space—I believe this is not essential to all mind, but accidental to the human mind—Our consciousness begins with the succession of sensations—Possibility of consciousness being developed in space as well as time—Touch, sight, and hearing minister to mind—Of these only the first two give cognition of space—Hearing is the most closely connected with thought, because we think in words—Sensations of different senses may give cognition of time, but only those of the same sense can give it of space—Case of a mind

developed out of the sense of sight only: its consciousness would be developed in both time and space—Illustration—What is meant by thinking in space—Possibility of a consciousness independent of time—Instance of this being believed in . . . . . Pp. 133—142

CHAPTER XXXVIII.

TIME, SPACE, AND CAUSATION.

I hold the experience theory of our knowledge of space and time in preference to that of forms of thought—But the experience is inherited: so that the results of the experience of the race become forms of thought for the individual—Herbert Spencer—The problem stated: How have space and time become forms of thought?—Is the fact ultimate, or a result of experience?—The experience theory—The ideal theory—The ideal theory was consistent with the psychology of Kant's time—Further conclusion, that space and time are unreal, admitted by Kant—The experience theory is consistent with our psychology—Notion that idealism is favourable to faith—I think the reverse—Kant was kept from scepticism by his faith, in spite of his philosophy—The experience theory makes our knowledge to be true, though limited, and is a possible basis of belief—Causation, like space and time, is cognised directly, by coming within the sphere of consciousness—Causation is cognised in becoming conscious of mental action—There is no direct cognition of the will as the cause of muscular action—How we learn to identify physical and mental causation as cases of the same law—Imaginary case of a being with thought, but no motor powers—Where I agree with Mill, and where I differ—Summary—Belief in the infinity of space and time—Difference between our belief of an eternal past and of an eternal future.

NOTE: *The Philosophy of Kant:*—The system of Kant's "Pure Reason" is idealism, identical with scepticism: that of his "Practical Reason" is faith. Pp. 143—151

CHAPTER XXXIX.

MENTAL INTELLIGENCE.

The most important question of biology is whether intelligence is a primary fact—I have argued the affirmative of organizing intelligence, and have now to argue it of mental—Difficulty of the latter question—There are no innate ideas—Thought begins from experience—Element of intelligence in all thought which is not a result of experience—Association will account for conceptions, but not for beliefs—Belief in the constancy of the order of things—How is this acquired?—Some say by habit only—I think this is no explanation—Belief is subject to the laws of habit, but habit cannot produce belief—Physical analogy—Objection from the inconstancy of the weather answered—The constancy of the order of things is not certain, but only probable: but it is certain to be constant unless interrupted—In what sense the law of causation is self-evident—This confidence is presupposed in action, and in desire and fear—The

only principles which enter into all reasoning are those of logic—These are known by intelligence without habit—They are involved in perception—The logical principle of identity—The idea of substance—Axioms of metaphysics—Beliefs not the results of thought, but implied in thought—Belief in the veracity of memory is an ultimate fact, and belongs to intelligence—Resemblance of my theory to idealism, and its difference—I believe the laws of thought are so because they are laws of nature—The question, should we expect to find nature constant if it were not so, is irrational—Intelligence is co-extensive with life, and not always conscious—Summary—Belief implies intelligence, as nutrition and growth imply organizing power—Intelligence dominates most in the highest life, both organic and mental—Peculiarities of the mind of man—Sense of holiness—Power of directing thought at will—Consciousness of self—Use of the personal pronouns—Intelligence needed for this.

NOTE A: *Bain's Theory of Belief*:—Quotation from Bain—His theory of belief is no explanation—Belief in substance—Mill on Bain—Bain on the belief in the veracity of memory—Mill on the same.

NOTE B: *Mill's Inductive Logic*:—Inductive and deductive reasoning—Reasoning from particulars to particulars—Quotation from Mill—Question of the origin of the belief in the constancy of nature . . . . . Pp. 152—168

CHAPTER XL.

HABIT AND VARIATION IN HISTORY.

The science of life and mind has been fully systematized, as have also been logic, mathematics, physics, and chemistry: but the sciences of the results of man's mental activity have not yet been systematized, including those of language, art, and society—The laws of these subjects depend on the laws of mind, but the converse is not true—In language are an intelligent and a habitual element—Comparative grammar is as yet only comparative etymology, but comparative syntax is to be hoped for—Language is an organism—As life constructs the organism, so thought constructs language—Variability of language, both in the forms of words and their meanings, comparable to variations in the forms of organs, and in their functions—Rudimentary organs comparable to silent letters—Morphological correlations, independent of function, comparable to inflections without meaning—Morphology and the science of language are both comparative sciences, and sciences of progressive change—The embryology of language is yet unknown—Historical science of the fine arts, involving the same principles as organic morphology and language—Morphology of art—Its progressive changes—English architecture—Roman, Gothic, and Oriental architecture—Love of novelty is the moving power in the progress of art—Habit is the reason of continuity in the history of art—Rapid changes in art—Substitution in England of Early Pointed for Norman—This is probably paralleled in the development of species—Intelligence in art modifying the materials given to it by unintelligent habit, without violating the consistency of a style—Instance in the modification of Gothic architecture for the display of stained glass—Politics—Continuity of history and gradualness of political growth are consequences

of the law of habit—Gradual variability of habit in morphology, language, art, and history—Analogy of political progress to mental education—Both consist in the formation of habits—Necessity of permanence in habits—Political bores —Conscious functions are later developed, both in the individual and in society —Government—Law—Habit ought to be controlled by intelligence—Conservatism and Liberalism—Institutions outlive their usefulness . Pp. 169—183

CHAPTER XLI.

NATURAL SELECTION IN HISTORY.

Production of new types of character in colonization—Average difference of emigrants from the parent stock—Direct effect of new circumstances—Natural selection by climate of a race suited thereto, and having a distinct character—This process is purely physical—Natural selection is also true of the moral world—History is determined by man's mental nature—Victory in human conflicts depends on moral causes—It does not depend chiefly on courage—Superiority of power in a primitive state due to the domestic virtues—The political virtues—The civic virtues—Virtue confers power—At first vanquished races were destroyed: afterwards they were subjugated—Political progress due to conquest—Ultimately, war ceases to be an agency of progress—Peaceful progress due to competition and natural selection—Justification of freedom.

Pp. 184—191

CHAPTER XLII.

INDIVIDUAL AND SOCIAL ORGANIZATION.

Division of labour in the organism and in society—Society is an organism—Nutritive and nervo-muscular organs—Industrial and political organization—Social, like organic development, is from the simple to the complex—The most highly organized are the largest and the longest lived—Constant change of material—Ground of the resemblance—Life is in both a mode of activity—Habit—Intelligence—Three differences between individual and social organization—Social organization does not depend on structure—In it the whole exists for the parts—It has no reproductive function—Are societies necessarily mortal? —Argument for the negative.

NOTE: *Herbert Spencer on the Social Organism*:—My objections on this subject to H. Spencer—Hobbes on the same subject . . . . . Pp. 192—197

CHAPTER XLIII.

THE CLASSIFICATION OF THE SCIENCES.

The present subject naturally comes at the end of the work—Any such classification must be imperfect—Subjects belonging to more than one science—Spectrum analysis: polarizing crystals: electro-chemistry—One science giving

suggestions to another, or furnishing materials to another, or supplying instruments to another—The telescope and the microscope—Connexion of mathematics with dynamics—The laws of dynamics imply those of mathematics—This kind of relation is to be the basis of the classification, which is to be a series—Such a series is only approximately possible—The order is from the simple and general to the complex and special—Summary—No single series in nature—First division into logic, and its applications—Logic, unlike the other sciences, is not an organon—Logical notation is not an instrument of reasoning—Logic is the initial science—Mathematical and physical sciences—Mathematics comes before physics—Algebra, arithmetic, and geometry—Sciences of matter and of life—Those of matter come first—Dynamical and chemical sciences—General and secondary dynamical sciences—The dynamical come before the chemical—Molecular physics, chemistry, and crystallography—Molecular physics defined—Crystallography—Two groups of the sciences of life—First, those of the properties of organisms—Morphology and physiology—Psychology—Second group not yet systematized—Tabular statement—Position of astronomy, meteorology, and geology in another series of sciences, whereof the subjects are not laws, but phenomena—I propose to call them the cosmic sciences—Parallelism of the abstract and the cosmic sciences—Its ground—Gradation of phenomena from the vastest to the smallest—Astronomy—Terrestrial magnetism—Meteorology—Oceanography—Geography—Geology—Mineralogy—Palæontology and the distribution of species—Correspondences between the two series—Tabular enumeration of the cosmic sciences—Imaginary case of a being coming near the universe: the order in which he would see its phenomena—Chain of laws, each link presupposing that which comes before it—Parallel to this in the arrangement of things—Living beings are small in proportion to matter—Matter is small in proportion to space—The widest laws are the simplest, and act through the longest time—The only certainly unalterable truths are those of logic—Time and space were before matter—Gravitation is the only constantly acting force—Life and mind are the latest products—The highest products are the least in quantity, and the last in time—Harmony of the mind of man with nature—Artistic rule of highest beauty in least quantity, and, in poetry and music, at the end—Not all knowledge is included in the sciences enumerated in this chapter—I believe in metaphysics and theology—Opposition of literature and history to science—Nature of historical science.

NOTE: *Comte and Humboldt on the Classification of the Sciences*:—My obligations to Comte—His series of the sciences—Where my series differs from his—Position of dynamics: of astronomy—Science of language omitted by Comte—My obligations to Humboldt . . . . . Pp. 198—220

CHAPTER XLIV.

REMARKS ON THE HISTORY OF SCIENCE.

Agreement of the historical order of the evolution of the sciences with their logical order—Illustration from painting a picture—The truth stated above is only approximate—The progress of science is twofold, deductive and inductive

—Mathematics is deductive, chemistry mostly inductive: the science of heat is both—The logical relations of a science are not always obvious at first—A science may originate independently, and usually has done so—What the early origin of a science depends on—Mathematics—Geometry and algebra—Chemistry—Sciences of observation are easier than those of experiment—Morphology—Science began at the point most remote from human life, and was consequently deemed useless: and still its moving power is not usefulness, but intellectual interest—The telegraph—All inorganic science depends on measurements of space.

NOTE:—Measurement of linear spaces: of velocity: of time: of force: of resistance: of energy . . . . . Pp. 221—227

CHAPTER XLV.

REMARKS ON THE LOGIC OF THE SCIENCES.

The more special and complex is the subject of a science, the less is mathematics applicable to it—In connexion with this, the facts of life are in some degree indefinite—This does not imply any uncertainty—The same is true of morals—Certainty without precision—Four fallacies and their origin: that logic is an organon of discovery: that mathematics is the type of science: that clearness and intelligibleness are tests of truth: that precision is the criterion of certainty—Extension of the use of the word science—Double method in science—Induction and deduction must co-operate—Theory and observation—Failure of each alone—Paracelsus—Meteorology—Historical science: its method is the same as that of physical science—Free trade—In what sense mathematics needs verification—Conclusion . . . . . Pp. 228—234

APPENDIX.

Three questions: Is life an ultimate fact?—Are organizing and mental intelligence ultimate facts?—Is the moral sense an ultimate fact?—I answer all in the affirmative—Moral sense—Intelligence—Life—Quotation from Huxley—My reply to it . . . . . Pp. 235—240

ERRATUM.

P. 59, note, *for* Leibe *read* Liebe.

HABIT AND INTELLIGENCE.

CHAPTER XXVII.

INTELLIGENCE.

WE have seen in a previous chapter that vital functions are to be classed as formative, motor, and sensory. Sensory functions develop into mental ones; and for the purpose of the present chapter I shall speak of functions as formative, motor, and mental. Formative, motor, and mental functions:

Formative, motor, and mental actions are all guided by intelligence. In the last two chapters I have endeavoured to prove that formative or organizing intelligence is an ultimate, inexplicable fact, not capable of being resolved into any other; and in what follows I shall take this as proved. Those who agree with me that the complexities of such organs as the eye and the ear are due to unconscious intelligence, will probably feel no difficulty in believing the same of such wonderful motor instincts as the cell-building powers of the bee and the wasp. These insects, in building their hexagonal cells, are manifestly guided by intelligence of some kind; but it cannot be conscious intelligence, for we cannot think that they have any conscious knowledge of those properties of the hexagon which make that form the most suitable to their purposes. The unconscious intelligence that guides the cell-building actions of the bee is exactly the same in kind with the

all guided by intelligence.

Instinctive intelligence of the bee,

the same in kind with

formative intelligence.

unconscious intelligence that determines the formation of its mouth and its eyes.[1] The only reason why we think there is anything exceptionally wonderful in such instincts as those of the bee and the wasp, is that they are comparatively uncommon. Instances of motor instincts, so definitely adapted to a very special purpose, are found in but a few out of the vast number of animal species; while every animal that has well-developed eyes presents an instance of the adaptation of means to purpose by unconscious formative intelligence, which is quite as definite as that shown in any motor instinct, and far more delicate and subtle. Considered in itself, and without reference to its being exceptional or common, the bee's eye is at least as wonderful as the bee's cell.

Instinct is not more wonderful than formative intelligence.

These instincts of bees and wasps are the most remarkable and the most extreme case of motor actions directed by a definite, intelligent purpose, which purpose is yet totally unconscious. But they are distinctly exceptional; so that, in order to understand the relations between the different intelligent functions, we must take a different class of instances, which show a direct, and not merely an inferred connexion between formative and motor intelligence.

Purpose in the formation and action of the iris.

There is no more clear and definite instance of the adaptation of means to purpose in the whole organic creation than in the structure of the iris, enabling it to contract, involuntarily and spontaneously, in order to protect the retina against too much light. The formation of the iris is a case of unconscious formative intelligence, and its action in closing against the light is a case of unconscious motor intelligence. The action of the iris, though a motor action, is as purely unconscious as the formative actions: it cannot be controlled by the will, it is not accompanied by consciousness, nor does it always even depend on sensation; for there is a kind of blindness in which the optic nerve does not transmit the sensation of light to the brain, and yet the iris opens and closes as in a healthy eye.[2] From this there is a perfect gradation to

[1] See Note at end of chapter.

[2] Carpenter's Human Physiology, p. 533.

those motor actions which are accompanied by consciousness, and are under the control of the will. The action of the eyelids in closing is sometimes voluntary, but is oftener performed spontaneously, without consciousness or will. The motion of the eyeballs is voluntary. And, to complete the evidence of a perfect gradation between the unconscious or involuntary actions, and the conscious or voluntary ones, it is asserted that in some few men the iris is capable of being opened and closed at will.[1] We find the same gradation between involuntary unconscious action and voluntary conscious action in the digestive system also. The actions of the stomach, muscular as well as chemical, are quite involuntary, and in a state of health are unaccompanied by sensation. The action of the throat in swallowing is involuntary, though accompanied by sensation. The action of the mouth in chewing and swallowing is mostly performed in obedience to sensation, with little direction from the conscious will, though it is capable of being controlled by the will. Finally, the action of the hands in conveying food to the mouth is altogether voluntary.

Gradation from unconscious to conscious and rational motor actions, in the eye,

and in the digestive organs.

In these cases of the motor actions of the eye and of the digestive organs, each distinct action has its own separate set of muscles. But this is not true of all motor actions. Coughing and sneezing, for instance, are actions that have a definite purpose—namely, the removal of obstructions from the air-passages—but have no special muscles for their performance. These, like the winking of the eyes, are performed in obedience to sensation, and are only in part under the control of the will.

Actions determined by sensation.

We thus see that there is a perfect gradation from those motor actions which, like the action of the iris in opening and closing, are neither conscious nor voluntary, but are determined by vital intelligence, through those which are determined by sensation with little control from the will, to the purely conscious and voluntary ones.[2] At one end

[1] Lewes's Physiology, vol. ii. p. 222. He also states that men have been able to stop the action of the heart at will for a moment.

[2] See the tabular statement of the organic functions, vol. i. p. 163.

of the scale is perfect unconsciousness; at the other is perfect consciousness. The muscular actions at the unconscious end of the scale are manifestly determined by the same organizing intelligence that fits the muscles each for its special work; the iris is determined to contract, not by any conscious intelligence, but by the same unconscious intelligence that formed it for contracting. The muscular actions at the other end of the scale, on the contrary—the motions of the artist's hand, for instance—are directed by conscious mental intelligence. But though there is consciousness at only one end of the scale, there is intelligence throughout. All motor actions are directed by an intelligence that adapts means to ends; but it is only in the case of the voluntary muscles that the intelligence is conscious. The unconscious closing of the iris and of the eyelids against light, and the unconscious motions of the throat and the stomach, are as truly adapted to a special purpose, and therefore (according to any possible definition of intelligence) as truly intelligent, as the most consciously determined motions of the artist's hand; and, as I have already insisted, the formative principle to which the structure of the eye is due is as truly intelligent as either.

All motor actions are intelligent, whether conscious or not.

For these reasons I conclude that vital intelligence is the same throughout. I believe the unconscious intelligence that directs the formation of the bodily structures is the same intelligence that becomes conscious in the mind. The two are generally believed to be fundamentally distinct: conscious mental intelligence is believed to be human, and formative intelligence is believed to be Divine. This view, making the two to be totally unlike, leaves no room for the middle region of instinct; and hence the marvellous character with which instinct is generally invested. But if we admit that all the intelligence manifested in the organic creation is fundamentally the same, it will appear natural, and what might be expected, that there should be such a gradation as we actually find from perfectly unconscious to perfectly conscious intelligence; the intermediate region being occupied by

Intelligence, unconscious and conscious, formative and mental, is fundamentally the same. This view includes instinct.

intelligent though unconscious motor actions—in a word, by instinct.

It is impossible to say at what point in the ascending scale of organization the mutual action of ganglia and nerve-fibres begins to be accompanied by sensation; and it is equally impossible to say at what point sensation begins to develop into consciousness. But what I wish to insist on here is, that intelligence is not the same thing with the consciousness of intelligence. Intelligence—a power transcending the ordinary properties of matter, and adapting means to purposes,—intelligence, I say, presides over all vital actions, whether formative, motor, or mental, directing each action to its specific end; but it becomes conscious only in mental actions—that is to say, only in thought; and it becomes perfectly conscious only in mature deliberate thought. All other thought, including all the mental operations of animals and young children, and by far the greater portion of the mental operations of even the most thoughtful men, is in a great degree unconscious. We cannot tell at what point consciousness becomes perfect, any more than we can tell where it begins: perhaps, indeed, it is never perfect; perhaps we have no thoughts of which we are able to give a complete account, even to ourselves. It is however certain, that so far from consciousness being necessary to intelligence, unconscious intelligence is the rule, and conscious intelligence the exception.

We cannot point out the beginning of sensation or of consciousness.

Most thought, perhaps all, is partly unconscious.

If these views which I have stated are true; and if the intelligence that adapts organic structures to their functions is fundamentally identical with the mental intelligence of man; it follows from the mere statement, that the intelligence which forms the lenses of the eye is the same intelligence which, in the mind of man, understands the theory of the lens; the intelligence that hollows out the bones and the wing-feathers of the bird in order to combine lightness with strength, and places the feathery fringes where they are needed,[1] is the same intelligence

Identity of formative, instinctive, and mental intelligence.

[1] See the explanation of the mechanism of flight, in the Duke of Argyll's "Reign of Law." The hollowing out of the bones of birds is probably the most wonderful adaptation in the motor system of any animal.

which, in the mind of the engineer, has devised the construction of iron pillars hollowed out like those bones and feathers; and the same intelligence that guides the bee in its unconscious shaping of hexagonal cells is also that which, in our minds, understands the properties of the hexagon.

This view of the essential identity of organic intelligence and mental intelligence is, I believe, generally received among the Germans; but it will be new to most English readers, who have been accustomed to refer all organic adaptations to creative wisdom directly. Such an hypothesis was inevitable for believers in a Personal Creator, at least so long as the world and all that it contains was supposed to have been created in a few days. But now that we know the antiquity of the world to be almost immeasurable; and now that arguments, which I believe to be conclusive, have been brought forward to prove that every organized form is the result, not of a simple creative act, but of slow development; it appears more reasonable to believe that this slow development has taken place, not in virtue of a fresh exercise of Creative Power at every one of the almost infinitely numerous stages, but in virtue of a principle of intelligence, which guides all organic formation and all motor instincts, and finally becomes conscious in the brains of the higher animals, and conscious of itself in man.

A special act of creation is not necessary for every new adaptation.

This view, as I have already remarked, has the great advantage of including instinctive intelligence as a case of the same general principle with all other intelligence. It leaves instinct mysterious indeed, but not more mysterious than all life, and not anomalous, as it was under the old view.

The view I have stated has also the advantage of removing certain very serious difficulties connected with the Divine Purpose of Creation. I refer especially to the existence of such animals as parasitic worms, which are as well adapted as any others for their mode of life, but have probably no sensation and certainly no consciousness, and inflict pain, disease, and death on animals that possess

Moral difficulties lessened by this view.

Parasitic worms.

both sensation and consciousness. On the theory of the independent creation of every separate species, these can only be regarded as instruments of torture devised by Creative Wisdom. But if we believe that they are descended from species which were not parasitic, and have become self-adapted to new habitats, their existence ceases to be anything more than a particular case of the question, why pain and disease are permitted at all.

Unnatural or immoral instincts.

The same remark applies to what have been called unnatural, but would be better called immoral instincts; such as the working bees slaughtering the drones, after they have fertilized the queen; the female spider endeavouring to devour the male as soon as she is fertilized;[1] the habit of some species of ants, of carrying off ants of other species when in the pupa state, and making slaves of them; the habit of the cuckoo of laying its eggs in the nests of other birds; and of the young cuckoo, of throwing the original tenants out of the nest to perish. It is surely easier to believe these instincts to be very peculiar and abnormal results of vital intelligence, than to believe each of them to be a special providential endowment.

It will probably be said that this identification of formative, instinctive, and mental intelligence is Pantheistic. This word is sometimes used very indefinitely, but the proper meaning of Pantheism is the identification of the Divine power and intelligence with the powers and intelligences that work in the world of matter and mind. I am not a Pantheist: on the contrary, I believe in a Divine Power and Wisdom infinitely transcending all manifestations of power and intelligence that are or can be known to us in our present state of being. The relation between the Creator and the creation is a mystery to us; not from want of information, but from want of a faculty for understanding it; and it must remain so until we have begun to "know even as we are known." On this question of intelligence, however, the following remarks will be sufficient to show that my position is quite consistent with Theism.

[1] Carpenter's Comparative Physiology, p. 427.

All matter is endowed with forces,

We know that matter has been endowed with forces of different kinds, gravitative and chemical, which forces are capable of producing motion. We know that matter, in being set in motion by the action of these forces, is not acted on from without: on the contrary, matter is acting as well as acted on. When, for instance, a mass moves, as in the fall of a stone, or when a fire burns and produces heat, which is atomic motion, the energy of the motion is neither created at the moment nor brought from without; it only becomes actual from being potential or latent. Energy, like matter, has been created. Energy or force is an effect of Divine power; but there is not a fresh exercise of Divine power whenever a stone falls or a fire burns. So with intelligence. All intelligence is a result of Divine wisdom, but there is not a fresh determination of Divine thought needed for every new adaptation in organic structure, or for every new thought in the brain of man. Every Theist will admit that there is not a fresh act of creation when a new living individual is born. I go a little further, and say that I do not believe in a fresh act of creation for a new species. I believe that the Creator has not separately organized every structure, but has endowed vitalized matter with intelligence, under the guidance of which it organizes itself; and I think there is no more Pantheism in this than in believing that the Creator does not separately cause every stone to fall and every fire to burn, but has endowed matter with energy, and given to energy the power of transforming itself.

and vitalized matter is endowed with Intelligence.

We have next to consider the law under which vital intelligence acts. This, so far as I can see, is only capable of being very indefinitely stated. The only law which is common to formative, motor, and mental actions alike is that their guiding intelligence tends to determine them in whatever direction is most favourable to the life and health of the organism. I do not think that even disease is any exception to this law. Many diseases, as for

Intelligence tends to guide all vital actions in

instance probably all eruptive ones, are due to the unconscious instinctive action of the vital forces in endeavouring to get rid of poisonous matter. And morbid growths, like cancer, probably consist of portions of the organism that have got away from the control of the general life, and lead a life of their own, parasitic on the rest, and ministering to their own life, though to the injury of the entire organism.[1]

the direction that is best for the health of the organism.

Disease is no exception.

The law that the actions of every organism are such as to minister to its own life and health is to be understood with this very important extension, that under certain circumstances it ministers not to its own private advantage only, but also to that of the race. Here is the ground of the reproductive and maternal functions; and, where vital actions are accompanied by sensation and consciousness, here is the ground also of the sexual, the domestic, and the social affections.

Vital actions minister not only to the individual, but to the race.

Reproductive and maternal functions.

Social affections.

Where sensation is developed, what is healthful is felt as agreeable, and what is destructive is felt as painful; and where conscious intelligence is developed, pleasure is consciously sought and pain is consciously avoided as such and for their own sakes. But the instinctive unconscious tendency to seek what is needful for life and to avoid what is injurious is developed far lower down in the organic scale than any sense of pleasure and pain: a daisy, for instance, opens to the light and closes at sunset, and a sea-anemone, which has no nerves and consequently no sensation, opens to the water and closes when the tide leaves it. The vital impulse to self-preservation is also the ground of the love of life and the fear of death. All organisms are constantly and instinctively employed in the work of self-preservation; and hence when consciousness arises, the preservation of life is thought of as desirable, and the destruction of it as fearful. But in every case—love of life, love of pleasure,

Development of unconscious action into conscious.

Love of life.

[1] See Carpenter's Human Physiology, p. 371. He leans to the belief that cancer is due to a morbid poison in the blood; but the question is an open one, and I think the opinion of the nature of cancer expressed in the text is favoured by the fact that, when not too far advanced, it may be cured by extirpation. See also vol. i. p. 157, note.

sexual, domestic, and social affection—the conscious feeling and the rational determination are developed later than the instinctive impulse, and are developed out of it. Reason differs from instinct only in being conscious. Instinct is unconscious reason, and reason is conscious instinct.

NOTE.

INSTINCT.

Instincts of social insects cannot be inherited.

Darwin's explanation by natural selection.

I think them due to Intelligence.

DARWIN endeavours to account for instinct, as for all other facts of life, by the law of natural selection. Concerning the instincts of social insects—bees, wasps, and ants—there is this peculiar difficulty, that characters cannot be inherited in the direct line, because the working insects have their reproductive organs undeveloped, and cannot propagate. Darwin points out this difficulty, and replies to it that natural selection may be applied to families as well as to individuals. He believes that the cell-building instinct of the bee, for instance, has been perfected by the survival of those swarms which constructed the most perfect hexagons, and consequently used their wax the most economically. This explanation postulates, what is certainly probable, that the same variation will affect all, or the great majority, of the bees of the same swarm. But I cannot think it a satisfactory explanation; and those who agree with me on the subject of Organizing Intelligence will have no difficulty in believing that instinct also is really a case of intelligence, though unconscious.

The instincts of the social insects are the most wonderful in the animal creation, but there are many others, the origin of which is equally hard to guess at. The nest-building instinct which is general among birds may perhaps be prompted by a kind of half-conscious intelligence. But we can scarcely attribute this to fishes; and yet there are at least two species of fishes—the Stickleback and the Gobius niger—that make nests.[1] And

[1] Carpenter's Comparative Physiology, p. 964.

how are we to account for the origin of so strange an instinct as that of the Arius, and of some other fishes, the male of which hatches the eggs in his mouth?[1] Questions of this sort, however, are neither more nor less difficult to answer than questions concerning the origin of special structures, as for instance the electric organs of some fishes; a case which Darwin mentions as one of special difficulty. Instincts of some fishes.

[1] Professor Turner, in British Association Report, 1866.

CHAPTER XXVIII.

MIND.

Definition impossible.

IN writing such a work as this, it would be an obvious proceeding to begin the chapters on mind, or mental life, by a definition of mind. So far as I see, however, this is not possible. It would be plausible to define mind as conscious life; but, as we shall see, there are mental actions which are not conscious. It would be plausible also to define mind as intelligence; but, if the conclusions of the last few chapters are correct, intelligence does not belong to mental life alone, but to all life whatever. The want of any exact definition, however, need not embarrass us much.[1]

Mind is developed out of sensation.

It is the mere statement of a fact to say, that mind begins with sensation, and is developed out of sensation. But it is equally true, that sensation does not constitute mind. Something more is needed; and I believe the common view is perfectly accurate, that this something is consciousness.

Consciousness: inexplicable.

What, then, is consciousness? I believe that consciousness, like sensation, is in itself utterly incapable of being explained; all that we can do is to define the relations of sensation and consciousness to each other, and to ascertain the biological conditions under which they arise.

[1] H. Spencer (see his Principles of Psychology) regards mind as the life of external relation, in so far as this is distinct from the nutritive life. I think, however, this is doubly inaccurate. It would include, as a mental phenomenon, the act of a climbing plant in swinging its tendrils in order to catch something (vol. i. pp. 167, 178); and, so far as I can see, it would exclude those thoughts and emotions which have no tendency to lead to action.

Sensation and consciousness are both feelings. To use logical language, feeling is the genus of which sensation and consciousness are species. All consciousness is consciousness of feeling. It is possible to have a feeling without being conscious of it, but it is not possible to become conscious without having feeling to be conscious of. In order to simplify the subject, it is better instead of feeling to speak of sensation, which is the simplest kind of feeling, and that out of which all other kinds are developed.

Consciousness is of sensation.

Sensation without consciousness.

Consciousness, then, is primarily consciousness of sensation. Sensation comes before consciousness; it is possible to have a sensation without being conscious of it. This is a truth within every one's experience, though it is not a very familiar truth, because the absence of consciousness is not likely to be noticed. It must often, however, have occurred to every one suddenly to become conscious of a sight that had been before his eyes, or of a sound that had been in his ears for some time; and to remark, "I saw (or heard) this, but was not conscious of it." But, what is still more conclusive than this, it is impossible to doubt that in sound sleep there is no consciousness of sensation; and yet when any one has become accustomed to sleep in a loud monotonous noise, as for instance that of a mill, it is well known that a sudden cessation of the noise will put an end to sleep, just as its sudden commencement would do. This proves that the sound must have reached the sleeper's sensorium, or in other words must have been heard, though his consciousness was, in the most literal sense of the word, asleep to it. This is a conclusive instance of the possibility of sensation without the consciousness of it.

Sleep.

We thus see that there may be sensation without consciousness; but there can be no consciousness without sensation. Consciousness is first awakened by sensation, and if it were not so awakened it would sleep for ever, or in other words would never come into existence. We consequently say that consciousness is developed out of sensation; the conscious or mental life is developed out of the merely sentient life, as the sentient life is developed out

Mental development.

of the insentient. I shall have to go into this subject in more detail in the next chapter; but before I do so, there are some more remarks to be made concerning the relation between sensation and consciousness.

Consciousness distinct from sensation.

The distinction between a sensation and the consciousness of the sensation is in my opinion a very important one, though it appears to be often overlooked.[1] The truth that they are distinct may be further illustrated by the fact, that a sensation which is felt as disagreeable at first, sometimes becomes agreeable when it is repeated often enough to become familiar. Hence is the very common yet really very remarkable fact of "acquired tastes." I am not now speaking of the feelings produced by poetry, by music, or by visual beauty; the feelings they produce are very different from mere sensations, and are much more complex; I mean tastes in the primary sense of the word, as belonging to the sense of taste. We know that there are flavours, the taste of which is disagreeable at first, and for which a liking is nevertheless soon acquired. It can scarcely be maintained that the flavour comes by repetition to produce a different sensible impression on the nerves of taste; in other words, it can scarcely be maintained that it comes to taste differently from what it did at first. I think it much more likely that the sensation itself continues to be the same, but the impression produced by the sensation on the consciousness becomes different. If it is said that this is no explanation at all of the fact that tastes may be acquired, I admit it; I admit that the hypothesis I advance explains nothing—or, in other words, does not make the fact we have to do with more intelligible; I only advance it as being what I believe to be a true statement of fact. So far as the fact of acquired tastes is capable of being explained at all, it can be explained only by referring it to the law of habit among sentient beings, that what is habitual tends to become agreeable.[2]

Acquired taste,

due to a change not in the sensation, but in the consciousness of it.

[1] Had this distinction been recognised, no one could have fallen into the monstrous absurdity (as I think it) of maintaining that insects have no *sensation*, because they have nothing homologous with the cerebrum of Vertebrata, which is the organ of *consciousness*.

[2] See vol. i. p. 188.

Another remarkable fact which has a kindred bearing to that last mentioned is, that consciousness perceives various analogies between the sensations of different senses, without the slightest approach to identity. Softness is a sensation of touch, yet we speak of soft colour. Sweetness is a sensation of taste, yet we speak of sweet sound. The propriety of these expressions is felt by every one, yet they are felt to be inexplicable: a real yet inexplicable analogy is felt between impressions received from different sensations. I believe that although the impressions of different senses—soft objects of touch and soft colour, sweet taste and sweet sound—are totally unlike in so far as they are merely impressions of sense, yet the impressions they produce on the consciousness are in some degree similar.

Analogous impressions from different senses.

Another fact concerning consciousness is, that so soon as consciousness, from being conscious of sensations and other feelings, becomes conscious of itself, it recognises itself as being simple and indivisible. Unlike the relations between sensation and consciousness of which I have spoken in the last two paragraphs, this is so obvious and indisputable that no sane person could possibly doubt it, and no proof or elucidation could make it more certain. Biology, however, has shown the physical ground of this mental or metaphysical truth. The ground of the unity and indivisibility of consciousness, or the mind, is that centralization of the nervous system which in all classes of animals appears to be a necessary condition of mind. Mind, or any approach to a mental nature, appears to exist only in the Vertebrata, the higher Articulata (such as insects and spiders), and perhaps the Cephalopodous Mollusca; and in all these classes the nervous system is not only complex but centralized—all those parts of the nervous system which control and dominate the rest being centralized in the head. The ganglia thus centralized in the head are in the Vertebrata called the brain. This is really a very complex organ, or rather a congeries of organs; but the unity of its action is so perfect that the mind feels itself to be, and really is, not a mere congeries of func-

Consciousness is indivisible.

Biological ground of this, in nervous centralization.

tions, but a living unity. This is primarily a metaphysical truth, or, in other words, a dictum of consciousness; but it is re-affirmed by biological observation. We have seen that many of the lower animals are not killed by being cut into pieces, but each separated part will continue to live, and will develop into a perfect animal. Some of the animals which have this property may be sentient, but we cannot think they are conscious.[1] If they are sentient, there is no difficulty in supposing that each of the separated parts continues to feel the same sensations that it felt before division (provided, of course, that it contains a sensory nervous centre); but it is impossible to conceive of consciousness being divided in this way. I do not say that such a division of consciousness is impossible, because it is inconceivable by the mind of man. I do not think highly of that kind of reasoning. What I say is, that the human consciousness affirms its own indivisibility, and that the facts of comparative anatomy and physiology tend to prove that such is the law of all consciousness whatever.

Sensation is divisible:

Consciousness not.

In speaking in a former chapter of the laws of habit, I said that all characteristics tend to become hereditary, subject to one important limitation. The limitation I spoke of is this, that consciousness is never inherited. This fact, that consciousness is not *transmissible*, may perhaps stand in some close connexion with the fact insisted on in the last paragraph, that consciousness is not *divisible*. Mental characters, like bodily ones, are transmissible, and often become hereditary, but the transmission is never accompanied with consciousness. Habits which have been formed by the conscious acts of the parents may be inherited by the offspring; but the habit is inherited without any consciousness of its origin. The offspring have no consciousness, or, what is the same thing, no memory, of the conscious acts by which the habit was formed in the parent. Hereditary habit is so much more conspicuous among animals than in man, that, in order to illustrate my meaning, it is

Consciousness not hereditary.

[1] We cannot say that such animals have any true individuality. See Note to Chapter XVI.

best to take an instance from among animals. Birds on uninhabited islands show no dread of man, but after they have become a mark for the sportsman for some time they acquire a dread of him, and this instinct becomes hereditary.[1] We cannot suppose that the birds which inherit this fear of man have any conscious memory of their parents or, it may be, their ancestors having been frightened by man. They inherit the fear, but not the consciousness of its cause. Selection will, no doubt, increase this tendency, by the less timid birds being killed. But the main cause is evidently hereditary habit.

Instance: how birds acquire a dread of man.

[1] This illustration has been suggested to me by a passage in H. Spencer's Review of Bain's Psychology, republished in H. Spencer's collected Essays.

CHAPTER XXIX.

THE PHYSIOLOGY OF MIND.

Differentiation into organs of vegetative and of animal life.

IN the chapter on the Direction of Development it has been stated that the fundamental differentiation in animal development is that into the systems of organs which belong respectively to the vegetative and the animal life. It is necessary for me to state over again part of what I have already stated in that chapter, though I now approach the subject from a different point of view. The organs of vegetative life essentially consist of an apparatus for transforming matter; those of animal life essentially consist of an apparatus for transforming energy. The

Contractility, the fundamental character of the latter.

fundamental attribute of the apparatus of animal life is contractility; that is to say, the characteristic power of muscular tissue to contract under the influence of a stimulus, and in contracting to transform energy from the vital into the motor form :[1] in other words, to do work by contracting. In those simple animals which have muscles but no nerves, as especially the Hydrozoa, the stimulus under which the muscles contract consists in the contact of food or of some other foreign substance ; and such a stimulus, if it is applied to one part of the animal's muscular tissue, will slowly propagate itself; so that, if one tentacle is irritated, the other tentacles will also contract. But in those more highly organized animals which have a complex nervous system, the stimulus under which the muscles contract usually consists in a flow of nervous energy. The difference between the action of muscles that usually contract under a stimulus applied to themselves, and muscles

[1] See the chapter on the Dynamics of Life.

that usually contract under a stimulus transmitted through the nerves, is not, however, a fundamental difference. The nature of the stimulus is the same in both cases; it originates in the same way, and affects the muscles in the same way. Between the case of a muscle that contracts from the stimulus of a foreign body coming into contact with the muscle itself, and one that contracts from the stimulus which the nerves transmit to it when a similar body comes into contact with the extremity of a nerve in some other part of the organism, there is probably not much more difference than there is between the act of ringing a bell in the hand and the act of ringing it at the end of a bell-wire; or, what is a better comparison, between decomposing water by the action of sulphuric acid on zinc while the acid and zinc are in the same vessel with the water, and effecting the same decomposition by arranging the acid and zinc in a voltaic battery, and sending the liberated energy, in the form of a voltaic current, along a wire to a separated vessel where the water is to be decomposed.

Nervous system developed out of muscular. Its primary function is to transmit stimuli to the muscles.

The nervous system is developed by differentiation out of the muscular system, and in its first and lowest development appears to have no vestige of sensation and no other function than that of transmitting stimuli to the muscles. The muscular tissue of the Hydrozoa, as stated above, transmits a stimulus but slowly. Nervous tissue, on the contrary, transmits it with a rapidity which is practically instantaneous; and this, of course, makes the motions more rapid, and the whole life more energetic, in those animals which have a nervous system than in those which are without one.

Nervous system never simple.

[1] It is, however, a very remarkable, and at present an inexplicable fact, that the nervous system is not, in any animal whatever, so simple as might be thought from the foregoing account of its functions. The nerve-fibres are in no case directly laid on, as it were, like telegraph wires,

[1] All the facts and opinions respecting the anatomy and physiology of the nervous system stated in this chapter are taken from Carpenter's Human Physiology, except where I advance any opinion as my own.

for the purpose of transmitting stimuli directly from the skin, or any other part which is more exposed to stimuli than the rest, to the muscles that have to make the response to the stimuli. In the simplest nervous system that appears to be possible under the laws of life, there must be at least two fibres, meeting in a ganglion, and acting one on the other through it. One of the fibres conducts the stimulus from the skin, or wherever its outer extremity is situated, to its inner extremity at the ganglion. The other fibre conducts the stimulus from the ganglion to the muscle in which it terminates, and causes the muscle to contract. This is what is called "reflex action;" the stimulus being, as it were, reflected from the ganglion.

Ganglia.

Reflex action.

As already mentioned, nervous structure is a development and outgrowth of muscular structure, being developed by differentiation from it. This is observed, both in watching the successive stages of the development of the highest animals, and in comparing the various members of the animal kingdom, from the simplest to the most complex development of a nervous system. And it will be obvious from what has been stated above, that nervous function also is a development and outgrowth of muscular function, being developed by differentiation from it. In the Hydrozoa, there are no separate organs for the purpose of transmitting stimuli, nor any organs at all which transmit them, except the muscles themselves. But when a nervous system is developed, the function of transmitting stimuli is separated from the ordinary muscular function, and assigned to the nerves.

Nervous function differentiated from muscular function.

In the simplest and lowest development of a nervous system, the action of the nerve-fibres on their ganglia is probably unattended by any sensation; and this continues to be true of large parts of the nervous systems even of man and the higher animals. Higher up in the animal scale, sensation appears: the action of some—not all—of the nerve-fibres on their ganglia produces sensation. We cannot tell where it begins. I think it most likely, that sensation begins where organs of special sense come into

Sensation does not exist at first.

existence; and as eyes are the most generally distributed of these in the animal creation, I think it most likely that sensation is nearly co-extensive with the possession of eyes. But this is incapable of proof: we have no criterion whatever of its presence or absence. Sensation is in itself, of course, perfectly inscrutable. It is utterly impossible that we can ever know how or why it is that the flow of a current of a peculiar kind of energy along a nerve to its ganglion should be accompanied by sensation. But we might have expected to find sensation the peculiar function of some particular kind of tissue, so that the presence of sensation might be inferred with certainty from its presence, and the absence of sensation from its absence. Such, however, is not the case. Some nerves and ganglia are sensory, others are not so; and the microscope, so far as we yet know, shows no difference whatever between the structure of the two.

It begins probably with special sense.

Sentient and insentient nerves histologically alike.

We thus see that the sensory function is not a primary or fundamental endowment of the nervous system, but has been added to its original functions in the course of development. The history of the development of the nervous *organs* is parallel with the history of the development of the nervous *functions*. The spinal cord, which is the principal nervous organ of the insentient life, is developed first in the embryo, and the sensory ganglia grow out of it. The sensory ganglia[1] are situated within the skull, but are distinct from the cerebrum, or true brain. Besides the ganglia of the special senses, there is among them a pair of ganglia called the *thalami optici*, which (notwithstanding their name) are believed to be the nervous centre for the sense of touch. In close proximity to the sensory ganglia is another pair of ganglia called the *corpora striata*, which are believed (though the subject is an obscure one) to be the ganglionic centres for the nerves of motion, in so far as

Parallel development of organs and of functions.

Corpora striata;

[1] In order to guard against a probable misconception, it ought to be stated that, so far as we know, the ganglia are not the seats of sensation any more than the nerve-fibres. Sensation is produced when certain ganglia receive a stimulus from their nerve-fibres; but the ganglion is insentient if acted on by pricking or in any other way except through its fibres, and the fibres are insentient if they are cut off from their ganglia.

motion is not merely reflex, but determined by sensation and will. The relation of these to the nerves and ganglia of sense is as follows:—An impression of sense is transmitted by some of the nerve-fibres of that sense to its ganglia, and the reception of the impression by the ganglia produces the sensation which is appropriate to that impression: the sensory ganglia, in their turn, act on the corpora striata, which are motor ganglia; and the latter send down the motor nerves whatever motor impulse is necessary in order to make the appropriate response to the sensation. For instance: a flash of light falls on the retina, and the impression is telegraphed by the optic nerve to the optic ganglia, where it produces the sensation of light; the optic ganglia act on the corpora striata, and cause them to send a motor impulse to the muscles of the eyelids, which closes the eyes, and thus makes the appropriate response to the impression of the flash of light. This is what Dr. Carpenter calls consensual action. The chain of cause and effect is exactly the same in consensual action as in merely reflex, except that in consensual action one of the links of the chain is sentient, and the motor action will not be produced unless sensation is felt. Both reflex and consensual action consist simply in, first, an impression sent from the exterior extremity of a nerve to the nervous centre; and, second, a motor impulse sent outwards from the nervous centre in response to the impression.

their relation to the sensory ganglia.

Consensual action:

its similarity to merely reflex action.

Sensation at first is only the guide to action.

It will be observed that in the foregoing account of consensual action, sensation is described as existing, not by itself, but only as the intermediate link between impressions received by the organism from without, and the muscular actions that constitute the appropriate response to those impressions. Sensation existing by itself, and not necessarily leading to action, appears to belong to a higher development of life, and to be the preparation for Mind. An insect may no doubt have sensations without making any motion in response to them: if such sensations exist, we can have no evidence of their existence. But we know that the first and lowest functions of the nervous system

appear to be purely reflex and insentient; these pass, by indistinguishable gradations, into consensual action; so that, at its commencement in the animal scale, sensation appears not to exist alone, but solely as the guide to muscular action.

Insects have only this,

The nervous mechanism described above is all that insects, or any other invertebrate animals, are known to possess. Their highest nervous organs consist of the nerves and ganglia of sense and motion, and their highest nervous functions consist in sensation, and the direction of motor actions by sensation. This at least is generally true, but it appears difficult to believe that ants and spiders have not some dawnings of conscious intelligence, like that of the higher animals. For the most part, however, the instincts of insects, wonderful as they are, consist in consensual, or sense-directed, actions, guided by unconscious vital intelligence,[1] kindred rather to the organizing intelligence which adapts the bodily structures for their functions, than to the conscious mental intelligence of man. Especially is this true of the cell-building instinct of the bee and the wasp; it cannot be supposed that those insects understand the geometry of the hexagon, and the unvarying perfection of their work is alone enough to exclude the idea of an intelligence which works in any degree like that of man.

with some possible exceptions.

If some insects have a vestige of conscious intelligence, its seat must be in the sensory ganglia. This would involve no great anomaly, for motor, sensory, and mental functions, including those of instinct, are much more variable between species and species than are the functions belonging to the inorganic life. Besides, the sensory ganglia of all insects appear to be the seat of perception: I mean the perception of external objects, as external; which, as I shall have to show further on, I believe to be a rational function, though the reason is unconscious of itself. Leaving the problematical subject of the consciousness of insects and spiders, we now go on to the consciousness of the Vertebrata, and especially of man.

[1] See the chapter on Intelligence (Chap. XXVII.).

The spinal cord[1] is the chief nervous centre of the insentient life; it is the first part of the nervous system that makes its appearance in the development of the embryo.

Sensory ganglia developed out of spinal cord,

Out of it are developed, by a process like budding, the nervous centres of the sentient life, consisting of the sensory ganglia, and the pair of motor ganglia called the corpora striata, which, as already intimated, are in the closest nervous connexion with the sensory ganglia. The nervous system of insects contains no parts of higher grade than these.

and cerebrum out of sensory ganglia.

But in the Vertebrata a distinct organ appears, which is developed by budding out of the sensory ganglia, as they are developed by budding out of the spinal cord. This is the cerebrum, or true brain; it is also called the cerebral hemispheres, for it is a double organ, though in man and the rest of the highest animals the two hemispheres are in close contact.

The cerebrum is the organ of consciousness.

We have every reason to believe that the cerebrum is the organ of consciousness and mind, as distinguished from unconscious instinct.

Largest in the highest animals.

In fishes, which are the lowest of the vertebrate classes, it is very small in comparison with the sensory ganglia, but it increases in size as intelligence increases in ascending the animal scale, until in man and the rest of the most highly organized animals the cerebrum is many times larger than all the rest of the nervous centres put together.

The cerebral hemispheres are often called ganglia, but this is not quite an accurate expression. Like the spinal cord, they contain masses both of ganglionic cells and of

Cerebrum not in direct connexion with the organs of external life.

nerve-fibres; but, unlike either the spinal cord or the sensory ganglia, their nerve-fibres are not in direct connexion with any of the organs of external life—with either the muscles or the organs of sense. The cerebral hemispheres consist of masses of fibres radiating upwards from the sensory ganglia, and terminating in masses of ganglionic cells which are continuously spread out under the

Its structure.

bones of the skull; and these ganglionic masses, both those of the two hemispheres and the various parts of the same

[1] Including the medulla oblongata, which, though within the skull, is really part of the spinal cord.

hemisphere, are connected with each other by other masses of fibres.

The functions of its parts can be ascertained only by analogy.

Concerning the functions of these various parts, we have no direct evidence whatever. We have no guide but analogy. With the help of analogy, however, I believe that a tolerably complete and satisfactory theory can be formed. I ought first to mention, that the theory of the so-called phrenologists is not only unproved, but disproved, by facts.[1] According to that theory, the cerebral hemispheres consist of a congeries of organs, in each of which a distinct mental function is localized—comparison, imagination, firmness, love of children, &c. Were this true, injuries to the brain would injure the mind in definite ways, according to the locality of the injury. But this is not the case; injuries to the brain, when the patient recovers at all, appear generally to leave the mind unaffected, even when a part of the substance of the brain has been lost; and they certainly do not affect the mind in any way that can be predicted when the seat of the injury, and its magnitude, are known. Experiments on animals yield the same result.

Phrenological theory disproved by facts.

One nervous current producing another.

We have seen that it is in accordance with the analogies of the nervous system, that a current along one nerve-fibre should determine a current to be sent along another fibre.[2] Thus, for instance, if the impression of a flash of light is telegraphed along the optic nerve to the sensory ganglia, a motor impulse is telegraphed along another nerve, causing the eyelids to close. I think it most probable that the nervous mechanism of consciousness resembles this. It is certain that sensation is produced by the flow of a current of nervous energy along a nerve-fibre of sense to its ganglion; the sensation of light, for instance, is produced by a current flowing along the optic nerve to the optic ganglia. Let us call this the *nerve-current of sensation.* Now, if consciousness is a feeling, which it certainly is;

[1] I think there is very probably, however, this much truth in phrenology, that there is a tolerably close correlation between the form of the brain (which determines the form of the skull) and the mental character.

[2] See Note at end of chapter.

and if the consciousness of a sensation is a distinct thing from the sensation itself, as I think I have shown in the preceding chapter; it is as probable as analogy can make it, that the consciousness of the sensation is also due to a nerve-current, like that of the sensation, but in a different fibre; and if so, all the evidence we have leads to the conclusion, that the *nerve-currents of consciousness* are formed in the fibres that connect the sensory ganglia with the ganglionic substance of the cerebrum. I consequently regard these fibres as the *nerves of consciousness*, just as the nerves which connect the organs of sense with the sensory ganglia are the nerves of sensation. A sensation is due to a current entering the sensory ganglia from a nerve of sensation; and I believe that the consciousness of the sensation is due to a secondary current being set in motion by the first, and flowing out of the sensory ganglia along the nerves of consciousness. Sensation is due to the action of the nerves of sense on the sensory ganglia, and I believe that consciousness is due to the action of the sensory ganglia on the nerves of consciousness, which are cerebral nerves.

Consciousness is thus produced.

Nerves and nerve-currents of consciousness.

A question arises here. Sensation and, as I have no doubt, consciousness also are due to the mutual action of a nerve-fibre and a ganglion. The nerves of sensation have ganglia at only one end; their other ends are in connexion with the organs of sense—with the eye, the ear, the skin, &c. But the nerves of consciousness have ganglia at both ends; at one end are the sensory ganglia, at the other is the ganglionic substance of the cerebrum. Is the consciousness of sensation due to the action of the sensory ganglia in *sending out* the current of consciousness along the cerebral nerve-fibres? or is it due to the action of the ganglionic substance of the brain, at the other end of the fibres, *receiving* the current? An answer to this question might appear impossible, and of course there is no direct evidence; nevertheless, I believe the same analogical reasoning which has guided us so far, will enable us to give at least a probable answer to this question also.

Is consciousness produced in the sensory ganglia or the cerebrum?

I have as yet spoken only of the consciousness of

sensation, which, after sensation itself, is the simplest and most elementary of mental functions. Beyond and above this are thought, and the consciousness of thought. I say thought and the consciousness of thought, because, as the consciousness of sensation is, as I believe, a distinct thing from the sensation itself, and there may be a sensation without the consciousness of it, so the consciousness of thought is a distinct thing from the thought itself, and there may be thought without the consciousness of it.

Consciousness of thought is distinct from thought.

Of the existence of unconscious thought there is ample evidence, and it is now generally admitted by those who have studied psychology. To mention a single instance of this—probably the commonest, but by no means the most remarkable: it is only by admitting that trains of thought, or suggestion, may go on in unconsciousness, that we can account for the mental phenomenon, which must often have come within every one's experience, of thoughts and memories coming suddenly into consciousness without anything whatever to suggest them, either in external circumstances, or in the thoughts that were consciously occupying the mind. I am myself very liable to this. Sometimes when my mind appears to be fully and consciously occupied; sometimes soon after wakening in the night, and when consciousness is perfectly awake but not occupied with any train of thought; I find recollections of places, of incidents, of lines of poetry, coming into my consciousness. The things thus recalled are often uninteresting and trivial, and they often, I feel certain, have not been in my conscious memory for years. I have frequently, on their occurrence, sought for any possible link of conscious suggestion by which to account for them, and made myself certain that there was none.

Unconscious thought.

Recollection without apparent cause.

But there is no effect without a cause, and if these recollections have not been suggested by any conscious process they must have been suggested by an unconscious one. It is scarcely possible to doubt that unconscious thought, as well as consciousness, must be a function of some part of the nervous system; every vital function, sentient or insentient, appears to have its own peculiar

nerves; and I think it is in the highest degree probable, that those nerve-fibres which connect the various parts of the ganglionic substance of the cerebrum with each other are the nerves of thought. The sensory ganglia are, as I believe, the seat of consciousness; the cerebral hemispheres are the seat of thought; and I think we may consequently conjecture, with great probability, that unconscious thought is due to nerve-currents flowing between various parts of the cerebral hemispheres, without entering the sensory ganglia; and that consciousness of thought is due to other currents, set in motion by these, and flowing from the cerebral hemispheres along the nerves of consciousness to the sensory ganglia. Owing to the remarkable power that nerve-currents have of setting one another in motion, currents in the nerves of thought generally start currents in the nerves of consciousness, and thought becomes conscious; but this is not always the case. Both sensation and thought are, I believe, in their own nature unconscious; and the nerve-currents of sensation and thought give rise to consciousness, not always, and not directly, but only by causing secondary nervous currents to flow along the nerves of consciousness.

Nerves of thought.

The sensory ganglia are the seat of consciousness.

Consciousness of thought, how produced.

My answer to the question I have asked above is consequently this: that consciousness of sensation is due to currents flowing along the nerves of the brain, upwards, from the sensory ganglia to the ganglionic substance of the cerebrum; and consciousness of thought is due to currents flowing in the opposite direction, or downwards, along the same nerves, from the ganglionic substance of the cerebrum to the sensory ganglia. In both cases, not the cerebrum, but the sensory ganglia, are the seat of consciousness; or, in other words, consciousness is due to the mutual action of the sensory ganglia and the nerve-fibres which connect them with the ganglionic substance of the cerebrum.

Seat of consciousness.

The foregoing theory of consciousness affords a complete account of the physical conditions of Memory. If it is admitted that the consciousness of a sensation is not the same thing with the sensation itself, it will necessarily

Memory.

follow that the memory of a sensation is a continuation or reproduction not of the sensation itself, but of the consciousness of it. The simplest and most rudimentary form of memory is when the consciousness of a sensation continues for some little time after the sensation itself has disappeared. This is usually the case, and I shall have to show in a future chapter, how it is necessary to some of the most elementary and important mental operations, that the consciousness of a sensation should thus outlast the sensation itself. There is no difficulty whatever in understanding it as a fact. Sensations, when intense, outlast the impressions that produce them; thus, to take the most decided instance, we continue to see a bright light after the eyes have been closed against it. This is evidently due to the current of nervous energy that flows along the optic nerve, and produces the sensation of light in the optic ganglia, continuing to flow after its exciting cause has ceased to act; and the nerves of consciousness, as I suppose, possess, in a higher degree than those of sensation, this property of continuing to transmit their currents after the exciting cause of those currents has ceased. This property may, perhaps, be a purely physical one, and may be comparable to the fact that some elastic bodies, when struck, vibrate longer than others. It is to be remembered that nervous currents are not currents of fluid, but currents of energy, like electric currents. That higher kind of memory which consists not in the continuation, but in the revival of the consciousness of sensation—as, for instance, when we recall what we heard or saw yesterday—is to be explained in a parallel manner. The revival of the consciousness of sensation —or, in a word, recollection—is due to the reproduction of a current in the nerves of consciousness, exactly similar (except generally in intensity) to the current to which the original consciousness of that sensation was due. But currents cannot produce or reproduce themselves; there must be an exciting cause for the currents of reproduced consciousness, or recollection, as well as for those of original consciousness, or consciousness of sensation. I

Its rudimentary form is a consciousness of sensation outlasting the sensation.

Recollection,

due to the reproduction of a current of consciousness.

believe that all currents of consciousness are secondary currents; those of original consciousness are excited by currents of sensation (though, as we have seen, they sometimes outlast their exciting cause); those of reproduced consciousness are excited by currents of thought. Currents of thought, both in exciting one another and in exciting currents of consciousness, act according to the law of mental habit, or, as it is usually called, the law of the association of ideas; of which I shall have to speak in a future chapter.

Consensual action produced by remembered consciousness.

In many cases, remembered consciousness acts on the motor nerves, and on the whole organism, exactly as the original sensation, or the consciousness of it, would do. The thought of a disgusting object, for instance, sometimes produces nausea. Dr. Carpenter mentions an instance of sea-sickness being brought on by the sight of a ship tossing on a stormy sea. Such cases are to be regarded as cases of consensual action—due, however, to reproduced consciousness, not to sensation or the original consciousness of sensation. Dr. Carpenter proposes to call these *ideo-motor* actions; indicating by this word that they are set going, not by a sensation, but by the revived consciousness, or idea, of a sensation.

In order, so far as it is possible, to complete the physiological theory of the mind which I am here attempting, it now only remains to speak of voluntary action.

Voluntary action.

Voluntary action is related to consensual action, in the same way that recollection, or reproduced consciousness, is related to original consciousness. As I have already stated my belief on the subject, the consciousness of a sensation is due to a nerve-current of consciousness being excited by the nerve-current of sensation; and the recollection, or revived consciousness, of the same sensation is due to a similar nerve-current of consciousness being excited by a nerve-current of thought. Thus, when I remember to-day the speech I heard yesterday, the revived consciousness of the sounds is just like the original consciousness I had of them when I heard them, only fainter; but the currents of consciousness were then excited by

currents of sensation, while now they are excited by currents of thought.

In an exactly similar way, the same action may be at one time consensual and at another time voluntary. All muscular action is produced by nerve-currents in the motor nerves; the action of the motor nerves and of the muscles which they direct is just the same in voluntary as in consensual action; it is only the stimulus, or exciting cause of the motor currents, that differs: in consensual action the motor nerve is excited to act by a current of sensation; in voluntary action it is excited to act by a current of thought. Thus, for instance, the sensation of a flash of light flowing in from the optic nerve may determine a motor current which will cause the eyelids to close, without the action of will, or even the production of consciousness. This is consensual action; but the eyelids may also be stimulated to close by a determination of will; in this case the exciting current is not a current of sensation, but a current of thought. I do not, however, suppose that the nerves of thought act directly on the motor ganglia; I believe the nerves of thought, in producing voluntary action, act on the motor ganglia, not directly but through the nerves of will. There are anatomical reasons for this belief. I have endeavoured to show how there are two distinct sets of cerebral nerves, which may be respectively identified as the nerves of consciousness and the nerves of thought; and I believe the nerves of will may also be identified.[1] As already stated, it is now believed that the pair of ganglia called the corpora striata really constitute the nervous centre for consensual and voluntary motion. They are connected with the ganglionic substance of the cerebrum by thick strands of nerve-fibres, and all analogy is in favour of the belief that these are the nerves of will; just as the fibres that connect the sensory ganglia with the

The same action may be at one time consensual, at another voluntary, according to the nature of the stimulus.

Thought acts on the motor ganglia through the nerves of will.

Position of the nerves of will.

[1] The whole of what I have said on the physiological theory of voluntary action is taken in substance from Carpenter's Human Physiology. I think, though I cannot be certain, that Dr. Carpenter would agree with what I have advanced concerning the physiological theory of consciousness and thought.

ganglionic substance of the cerebrum are the nerves of consciousness. I suppose, consequently, that when action is purely voluntary, the process is this: A current in the nerves of thought (which, as stated above, are not in direct connexion with either the sensory or the motor ganglia)—a current in the nerves of thought, I say, determines a current in the nerves of will; and this acts on the motor ganglia, so as to determine muscular action, exactly as a current of sensation would do.

Voluntary actions may become consensual.

It is a very important fact, that actions which were voluntary at first may become consensual through habit. The best instance of this is afforded by the act of learning any manual art, especially music. In learning to play from printed notes, every movement of the fingers must at first be made to correspond with the notes by a conscious and voluntary determination; but by long practice the intermediate links of consciousness and will may be gradually left out, and the motions of the fingers may be consensually directed by the sight of the printed notes. In man, the greater part of what have become consensual actions, have become so by such a process. Even the act of walking is not instinctive in children, or in other words is not originally consensual, but has to be learned. Among many animals, actions that were voluntary at first have not only become consensual in the individual, but, by hereditary transmission, have become so in the race. One instance of this is the tendency to fly from man which, as mentioned in the preceding chapter, has become hereditary among many races of birds to which it was not originally natural. But the acquired instincts of the domestic races of dogs are yet more remarkable. Young pointers often point the first time they are taken out; and Darwin states that the tendency to run round a flock of sheep instead of at them has become hereditary in the sheep-dog.

Instance of a musician.

This may become hereditary in animals, as in birds,

and in dogs.

This explanation will not apply to all consensual actions.

But are all consensual and instinctive actions to be thus accounted for?—in other words, were all consensual actions voluntary at first, and have they only become consensual through habit? Were we to study man only, we could scarcely avoid the conclusion that such is the case;

but our conclusion would be wrong. The comparative absence of instinctive powers, and the vast development of thought, in man, makes the study of human psychology in some respects misleading, if it is not corrected by comparison with that of the lower animals. But a study of animal instinct shows that there are many consensual actions which never can have been voluntary. The cell-building instinct of the bee, for instance, certainly cannot be the result of consciousness and will, either in the bee itself or in any of its ancestors: I believe it to be due to unconscious vital intelligence. All analogy leads to the belief that voluntary action is developed out of consensual action, and not the converse; and consensual action has certainly been developed out of insentient or purely reflex action.[1] It is a general law, that the higher makes its appearance later than the lower, and is developed out of the lower; and in this particular case we know that, both in the development of the individual and in the ascending scale of organic forms, the cerebrum—which is the organ of consciousness, thought, and will—makes its appearance later than the sensory and motor ganglia, which are the organs of consensual action; and the sensory and motor ganglia make their appearance later than the nervous organs of the insentient life, which, in animals that have a nervous system at all, are the organs of reflex action.

Instance of the bee.

Voluntary action has been developed out of consensual, and consensual out of insentient.

The facts and theories concerning the nervous organs of mental life, and their functions, which I have stated in this chapter, may now be briefly summarized; leaving out of account the nervous organs of the insentient life; and also leaving out the cerebellum, a nervous centre probably belonging to the motor and instinctive life, though its functions are not yet clearly ascertained.

[1] I think that Professor Bain's theory of the will is vitiated by not attending to this truth. He represents the will as originally set in action by pleasurable and painful sensation. I believe the will has its root in reflex action, anterior to the origin of sensation.

Summary. The various nervous actions belonging to sentient and mental life may be enumerated as—

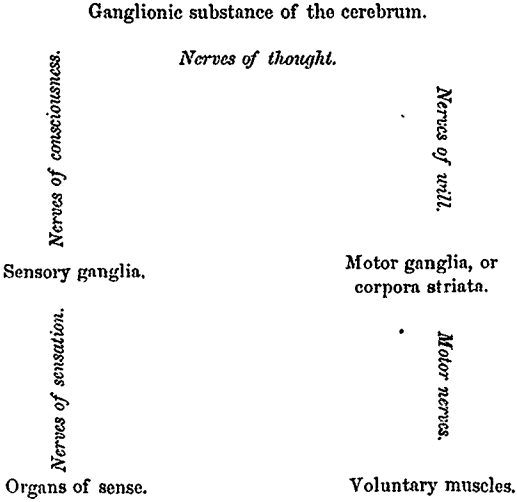
Enumeration of mental actions.

Sensation,
Motor action,
Consciousness (including Memory),
Will, and
Thought.

Each of these has its own special nerve-fibres, and is caused by the mutual action of the fibres and the ganglia with which they are connected—or, in other words, by nerve-currents flowing from the fibres into the ganglia, or the converse. A current of one kind can determine the production of a current of another kind, according to definite laws.

Mutual relation of the nervous organs of mind.

The position of the ganglia and nerve-fibres of mind may be represented in the following diagramatic form:—



Sensation. All mind begins with sensation: the first fact of mind consists in currents flowing upwards from the external

organs of sense, and producing sensation as they enter the sensory ganglia.

Consensual action

Sensation sometimes determines the flow of a downward current from the motor ganglia along their nerves to the muscles, causing muscular motions. This is what is called consensual action.

Consciousness of sensation.

Sensation sometimes determines the flow of an upward current from the sensory ganglia along the nerves that connect them with the ganglionic substance of the cerebrum, producing consciousness. This is original consciousness, or consciousness of sensation.

Thought.

Consciousness generally determines the flow of currents along the nerves that connect the different parts of the ganglionic substance of the cerebrum with each other, producing thought.

Consciousness produced by thought.

Thought is not itself conscious; but it generally, though not always, becomes so by producing currents in the nerves of consciousness. Consciousness thus produced by thought sometimes takes the form of the revival of the consciousness of a sensation, in which case it constitutes the recollection of the sensation.

Will.

Thought is capable of acting on the motor ganglia by means of currents sent down the nerves of will. The motor ganglia respond to the stimulus exactly as if it were a stimulus to consensual action coming from the sensory ganglia: they send the proper current down the motor nerves to the muscles, causing voluntary muscular motion.

Even as a very brief outline, the foregoing list of the various kinds of mental interactions is incomplete. It leaves out all but what may be called the primary classes of interactions. When we come to the laws of association, we shall have to speak of secondary classes of interactions, which are governed by those laws.

The phenomena of sleep, dreaming, and somnambulism depend on the partial or total suspension of the activity of various nervous centres of the mental life, and on the

partial or total suspension of communication between them by their nerve-fibres.

This last expression may need explanation. Independently of that lowering of the activity of the nervous centres in which sleep consists, the fibres that connect them appear, in particular cases, to cease to transmit any messages, or to keep up the communication. Thus, in the state of reverie, the nerves of consciousness and thought may be intently occupied with memory, reasoning, or invention; while the sensory and motor nerves, with their ganglia, may be engaged with some consensual action, such as the practice of some easy mechanical occupation; but the mind may have no consciousness of what the eye is seeing, or what the hand is doing: in physiological language, the currents of sensation that reach the sensory ganglia excite no currents in the nerves of consciousness.

Reverie.

In sound sleep, the whole activity of the cerebrum appears to be suspended, including the nerves of consciousness and will, as well as those of thought. The activity of the sensory and motor ganglia is very much lowered, though consensual actions are still possible, such as turning round during sleep.

Sleep.

Dreaming appears to be an intermediate state between sound sleep and reverie.

Dreaming.

The peculiarity of somnambulism appears to be that the action of the nerves of consciousness is suspended, while all the rest of the nerves of mind are at work as in the waking state. The actions of somnambulists show that their senses must be awake, and capable of guiding consensual action. Thought and will are also active, and yet there is no consciousness. Somnambulism appears to be the only mental state in which determinations of the will are made unconsciously. It has been well remarked, that dreaming and somnambulism are the opposites of each other. In dreaming, the consciousness is partly awake, though it is not in communication with the organs of sense, and the other mental powers are asleep: in somnambulism, the consciousness is asleep, and the other mental powers are awake.

Somnambulism.

Grounds of theory stated.

As the theory stated in this chapter concerning the functions of the three different sets of cerebral nerves is avowedly propounded as only a hypothesis, I shall conclude by stating, more distinctly than I have yet done, the evidence on which it rests.

Functions of sensory and motor nerves and ganglia are known.

Even if we had no direct evidence on the subject, analogy would make it impossible to doubt that every nerve and every ganglion must have its own separate function. But we have direct evidence: anatomy, and the results of experiments on living animals, combine to show, with tolerable distinctness, which are the nerves and ganglia of sensation, and which are those of motion; and the theory of reflex and consensual action is perfectly well established. But these methods fail us in the inquiry about the functions of the cerebral nerves. We cannot doubt that nerves in connexion with the organs of sense are nerves of sensation, and that nerves in connexion with the muscles are motor nerves; but when we come to the cerebrum we have no such facts to guide us, and the method of experiment cannot be applied. It is, however, impossible to doubt that in the cerebrum, as in all other organs, different nerve-fibres have different functions; and analogy may guide us, as I think, to a tolerable degree of certainty as to what the functions are.

Those of the cerebral nerves may be inferred by analogy.

Anatomy has shown that there are three distinct sets of cerebral nerves, having distinct connexions. These are to be thus enumerated:—

Cerebral nerves

1. The fibres connecting the sensory ganglia with the ganglionic substance of the cerebrum. I regard these as the nerves of Consciousness.

of consciousness,

2. The fibres connecting the different parts of the ganglionic substance of the cerebrum with each other. I regard these as the nerves of Thought. And

of thought,

3. The fibres connecting the ganglionic substance of the cerebrum with the corpora striata, which are the nervous centres for motor action. I regard these as the nerves of Will.

and of will.

As a parallel to these anatomical facts, the purely psychological (or what is usually called the metaphysical)

Three primary mental functions,

analysis of the facts of Mind has shown that there are three primary mental functions: that is to say:—

Consciousness, or Feeling:
Thought: and
Will.

probably corresponding thereto.

It is at least a probable hypothesis, that the three sets of cerebral nerves correspond to the three primary mental functions. But how are the respective functions of the three sets of nerves to be identified? Here it is important to remember, that although thought and will are usually accompanied by consciousness, they are not always so: there may be unconscious thought, and the facts of somnambulism appear to show that there may be unconscious voluntary determinations. These facts greatly strengthen the probability that the nerves of consciousness, at least, are distinct from those of thought and will. Now, how are we to identify the nerves of consciousness? It will be seen that of the three sets of cerebral nerves, as enumerated above, only one is in connexion with the sensory ganglia, leading up from them to the ganglionic substance of the cerebrum. The functions of these nerves must have something to do with the functions of the sensory ganglia. But they are not nerves of sensation. The nerves of sensation are those which are in connexion with the external organs of sense. They may be, however, and I believe are, the nerves of consciousness: whether the primary consciousness of sensation, or the secondary consciousness of memory and thought.

Nerves of consciousness distinct from those of thought and will.

Nerves of consciousness, how identified.

The same kind of reasoning applies to what I believe to be the nerves of thought. The mass of the ganglionic substance of the cerebrum, and of the fibres connecting its different parts, varies as between different species of animals and between different individuals among men, in some kind of approximate proportion to their intellectual powers; and it is doubted by none that the cerebrum is the organ of thought. Thought, as we have seen, is not necessarily conscious. That is to say, it is in itself unconscious, though it is usually accompanied by consciousness.

Thought is in itself unconscious.

Being itself unconscious, its seat cannot be in the nerves of consciousness; and I think all analogy is in favour of the hypothesis that the currents of thought are formed in the nerve-fibres that connect the different parts of the ganglionic substance of the cerebrum with each other; or, in other words, that thought is due to the mutual action of the ganglionic substance of the cerebral hemispheres, and the nerve-fibres that connect the different parts thereof. It is a very significant fact, that "it is on the very large proportion which the commissural fibres [or those which I regard as the nerves of thought] bear to the rest, that the bulk of the cerebrum of man and of the higher animals appears chiefly to depend; and it is easy to conceive that this condition has an important relation with the operations of the mind, whatever be our view of the relative functions of different parts of the cerebrum."[1]

Nerves of thought.

If my reasoning is assented to thus far, there can be little difficulty in identifying the nerves of will. We find a set of nerve-fibres which by their position serve to connect the ganglionic matter of the cerebrum with the corpora striata, which are the motor ganglia for consensual motions. Analogy points to these fibres as the probable channel by which determinations of will, formed in thought, are conveyed to the motor organs.

Nerves of will.

I will here anticipate a possible difficulty. What is the physiological distinction between ideo-motor actions (to use Dr. Carpenter's expression) and voluntary ones? Suppose, for instance, that I decide, on deliberation, to draw back from a position of danger, and do so; this is voluntary action. Suppose, on the contrary, that I do not wait to deliberate, but involuntarily shrink back from the thought of danger, perhaps contrary to my better judgment; this is an ideo-motor action, and differs from a consensual one only in the feeling that prompts it being not sensation but consciousness of thought. The stimulus to ideo-motor actions, and the stimulus to voluntary actions, both proceed originally from thought, and consequently from the nerves of thought. But the stimulus to voluntary action comes

Ideo-motor and voluntary actions: how distinguished.

[1] Carpenter's Human Physiology, p. 577.

from the ganglionic substance of the cerebrum to the motor ganglia directly, through the nerves of will; the stimulus to ideo-motor action, on the contrary, comes through the nerves of consciousness; and they do not act on the motor ganglia directly, but through the medium of the sensory ganglia, which, as I have shown reason to believe, are the ganglia of consciousness.

The theory incomplete.

I admit that the physiological theory of mind, of which I have in this chapter drawn the outline, is but an outline, which may probably never be filled up. Among other deficiencies, it gives no account of one of the most remarkable and yet common of mental facts, namely the act of attention; which may be defined, as the direction of consciousness by a voluntary act. In any but the most elementary psychological inquiries, physiology is of little or no use as a guide.

NOTE.

NERVOUS CURRENTS.

Consciousness is always a secondary phenomenon.

If my theory of consciousness is correct, consciousness is always a secondary phenomenon. The consciousness of a sensation is due to a current in the nerves of consciousness, produced by a current in those of sensation; and, similarly, the consciousness of a thought is due to a current in the nerves of consciousness, produced by a current in those of thought. One current of consciousness may, however, produce another, according to a law to be stated in the next chapter.

The secondary current is not a continuation of the first.

It is to be observed that the second current is not a mere continuation of the first, but is in every sense distinct. In order to illustrate my meaning, it will be best to take instances from the working of the electric telegraph. Telegraphic instruments may be so arranged that an electric current sent from London may make a signal by deflecting a magnetic needle at York, and then go on and make a signal at Edinburgh. But nothing like this takes place among nervous currents. The

Compared to electric telegraph currents.

only analogy in telegraphy to the production of secondary nervous currents is the action of a "relay battery;" that is to say, a battery which is so placed that on the arrival of one current it sends on another. The second current here is not a continuation of the first, but has been produced by a distinct battery. Just so, a secondary nervous current is not a continuation of the primary one, but is produced by a distinct action of nerve-fibres and ganglia on each other.

Nerve-fibres are more than merely conductors.

I may here state, that I think Mr. Lewes is quite right in maintaining that nerve-fibres are not merely analogous to telegraphic wires. They are, no doubt, conductors of nervous energy, but they are also necessary to its production. The mutual action of a nerve-fibre and a ganglion is necessary to the production of a nervous current, just as the mutual chemical action of two substances is necessary to the production of a voltaic current.

CHAPTER XXX.

CONSCIOUSNESS AND THOUGHT.

IN the foregoing chapter, I have attempted an analysis of the different mental functions, only so far as such an analysis illustrates, and is illustrated by, the anatomy and physiology of the organs of mind. That anatomy and physiology are, I believe, most valuable guides for the first few steps in the analysis of mental functions, but beyond the first few steps they fail us altogether. I have no doubt that Mind, in its very highest functions as truly as in mere sensation, is dependent on nervous action; but, beyond broadly discriminating between the nerves of consciousness, of thought, and of will, we have no means of identifying the nervous actions to which particular mental actions are due. All psychology, therefore, except in its most elementary parts, must be studied as a distinct science, without further help from physiology. This, however, is not because bodily and mental functions are really distinct, but only because we are unable to trace the connexion. But though it is impossible to trace the dependence of mental on nervous action in particular cases, that dependence is proved as a general truth by all analogy, and by much direct evidence: such as the fact that great mental power is never found without a well-developed cerebrum[1] (though the converse does not appear to be true); that mental exertion, like bodily exertion, exhausts

Physiology is useless as a guide in any but elementary psychology, though all mind depends on nervous action.

Proofs of this.

[1] I do not say a *large* cerebrum. Great intellectual power is sometimes met with in brains not above the average size. But there is certainly no instance of great intellectual power in an abnormally small brain, or in a malformed one.

nervous energy, which requires to be renewed in sleep; and that, as muscular exertion causes decomposition of the substance of the muscles, so mental exertion causes decomposition of the substance of the brain, separating phosphorus, which is found in the excreta.

We have seen reason to believe that there are separate cerebral nerves for consciousness, thought, and will; and we have seen that these correspond with the three primary mental functions of Feeling, Thought, and Will.

In speaking of the results of psychological analysis, I say feeling, thought, and will, rather than consciousness, thought, and will. Feeling includes consciousness, but it also includes sensation. All action of the sensory ganglia produces feeling: those feelings which originate in impressions coming from the external organs of sense, or from the external termination of any of the nerves of the body, belong to sensation; those feelings which originate within the brain itself belong to consciousness. The simplest, and the primary form of consciousness, is the consciousness of a sensation while it is present; out of this, all other forms of consciousness are developed. The next form of consciousness is memory, or the consciousness of a sensation which is no longer present. Beyond this are that large class of feelings or emotions, which, to use H. Spencer's felicitous expression, are "generated independently in consciousness," and have no prototype in mere bodily sensation. The most elementary of these are desire of the pleasures, and fear of the pains, of sensation; but beyond these elementary emotions are that higher class of feelings which attach themselves not to sensations but to higher objects, including the sense of beauty and the social and moral feelings.

Feeling is wider than consciousness.

Feelings of sensation and feelings of consciousness.

Gradations of consciousness.

Emotions.

Thus we can classify feelings. We can identify the nervous organs of sensation and consciousness, and ascertain the physical conditions under which feelings of sensation and consciousness arise; and we can trace the origin of one class of feelings out of another by development within the mind itself (as, for instance, memory out of sensation, and desire and fear out of the consciousness

of pleasure and pain). But when all this has been done, that whole class of facts which are variously called feeling, sensation, consciousness, and emotion, remains unexplained, and incapable of explanation. We can compare one feeling with another, and to a great extent we are able to ascertain where, when, and how, feelings *arise*. But it is in the nature of things impossible to tell what a feeling *is*. A man born blind may be made to understand that the colour of green arises when the eyes are directed to grass or leaves: and this is real knowledge, so far as it goes; but no possible explanation could make him understand what the sensation of green is. To use a mathematical mode of speech, sensation and consciousness cannot be described in terms of anything but themselves.

Feeling is inexplicable.

Thought is explicable.

But with thought it is otherwise. Thought—even unconscious thought—is always derived from conscious elements, and may be described in terms of consciousness. It is, I believe, universally admitted, that all thought begins with sensation; but sensation, and the consciousness of sensation, are not themselves thought.

It begins with the sense of the relation of sensations to each other.

The first elementary act of thought is the consciousness, not of sensations, but of the relation of sensations to each other;—the consciousness, for instance, of the likeness or unlikeness between two or more sensations, or of their co-existence or succession in time, or of their co-existence or separation in space. Now, when there are two or more feelings present to the consciousness at once, the consciousness is generally directed to one more than to the rest; or, in common language, the mind attends to one rather than to the rest. For instance, if music and talk are both going on at once, the attention will probably be directed either to the music or to the talk, but not to both. This sometimes takes place involuntarily, sometimes by a voluntary determination. In such a case as this, the consciousness is directed to one sensation, or set of sensations, rather than to the other. But the consciousness is also capable of being directed, not to a particular sensation or set of sensations, but to a particular relation or set of relations between sensations. The best instance of

Attention to one particular sensation,

or to one particular relation between sensations.

Instance in geometrical study.

this that I can think of, is that afforded by the use of a geometrical diagram. The lines of the diagram may be either drawn in white chalk on a black board, or in black ink on white paper; but it makes no difference whatever to the geometrical student whether the lines are black or white, nor would it make any if they were red or green. It is necessary that the lines should be of some colour, in order to make an impression on his sight: were there no difference of colour or of shade between the lines and the ground they are drawn on, there would be no sensations with which to begin the consciousness of relations between the lines. But one colour will do as well as another, because his consciousness is not occupied with the colours of the lines and of their ground, or with the relation between them considered as a relation between colours, but with a particular kind of relations, namely relations in space, which are the same for lines of any possible colour, and which constitute the subject-matter of geometrical science.

I ought to say, that I do not mean to prejudge any metaphysical question as to the nature of geometrical truth. Whatever may be the nature of the truths of geometry in themselves, or in relation to all possible intelligence, it is an unquestionable fact that we begin our knowledge of geometry, and indeed of everything, by cognition of sensations and of the relations between sensations.

Neither sensation, nor the consciousness of sensation, is thought: the first rudimentary act of thought is the consciousness of the relation between sensations. This, I believe, will be admitted by all. But I am inclined to think that it is not strictly accurate to speak of consciousness of relation; though it is sufficiently accurate not to be misleading up to the present point of the discussion. I am inclined to think that when we say that we are conscious of the relation between two sensations, we really mean that we are conscious, not of the relations, but of the sensations which are related. The relations of geometry are too abstract to be of much use for illustration here; we must take an example from among what is nearer to mere sensation. If I look at a half-open moss rose, I see red

We have no real consciousness of *relations*, only of *related things*.

petals in contact with a green calyx. Here are the two sensations of red and green, related to each other as unlike, and as in contact. I am then conscious of *two unlike sensations in contact;* but I am not, nor can I be, conscious of the abstract relations denoted by the words "unlikeness" and "contact." I am not conscious of abstract unlikeness, but I am conscious of unlike sensations; I am not conscious of abstract contact, but I am conscious of sensations in contact. Relations, in themselves, cannot be objects of consciousness. But they are objects of knowledge: this is a fact of experience, explain it logically or metaphysically as we may. I consequently prefer to say that we are *conscious* of sensations, and *cognizant* of the relations between them.

But we have knowledge of relations.

There is nothing new in all this. I expect that the one half of my readers will say that it is a mere truism, and the other half that it is a verbal distinction without any meaning behind it. I have no objection to its being called a truism, but I believe that, so far from being without meaning, it shows us where to seek for the explanation, in so far as it is explicable, of the fact of unconscious thought. Consciousness has to do with feelings. Thought has to do with the relations between the feelings, or with relations between these relations, or with a third set of relations between the second set of relations, and so on, in almost indefinitely increasing degrees of abstractness; that is to say, of remoteness from the feelings or sensations on which all thought is nevertheless ultimately based. (I do not offer this as a complete account of the objects of thought, but only as an account of how thought arises.) Now, it is possible to go on thinking of the relations, and the relations between the relations, after we have ceased to be conscious of the feelings which were the subjects of the relations. And this, I believe, is the *rationale* of the fact of unconscious thought.

Unconscious thought thus explained.

Thought ceases to be conscious when it is of relations only, to the exclusion of the feelings between which the relations are.

It may be said in reply to this, that, if it were true, mathematical and all highly abstract reasonings would be performed unconsciously. I reply to the objection, that I believe such reasonings are in a great degree performed

unconsciously; and that what we are conscious of while engaged in them is not so much the object under attention, as the effort of will which is needed in order to keep the thought at work; for in the normal state of the mind the exercise of will appears to be always accompanied by consciousness. But when thought is independent of will, it is also frequently unaccompanied by consciousness. Men of inventive minds say that their happiest thoughts have often come to them involuntarily, almost unconsciously, unsought, they know not how; that is to say, as the result of unconscious or half-conscious thinking.

What is taken for consciousness of thought is often really consciousness of mental effort.

CHAPTER XXXI.

MENTAL HABIT.

All actions tend to become habitual.

IN the chapter on the Law of Habit I believe I have shown that all vital actions whatever tend to repeat themselves, and consequently to become habitual. We have seen that every vital action may be classed under one of the three denominations of formative, motor, and mental. It is not a usual form of expression to speak of formative habits, but I think I have shown that it is strictly accurate; and to speak of motor and mental habits—that is to say, habits of action and habits of thought—is at once scientifically accurate, and in accordance with general usage. When habits are spoken of without any qualifying word, it is motor habits that are generally meant; and, indeed, the whole organic creation contains no better illustration of the formation of habit—individual, not hereditary habit—than the power of human beings so to learn mechanical arts, that actions which at first were performed by a conscious effort of the will, at last become consensual and unconscious; so that (to return to a former instance) a musician's fingers may be so trained as to be guided almost, if not quite unconsciously, by the sight of the printed notes.

Motor habits.

Voluntary actions becoming habitual and consensual.

Mental habit, or association of ideas.

The law of mental habit is usually called the law of the association of ideas. The association of ideas is a subject that has been very much studied, and to good purpose; indeed, few subjects are more thoroughly explored or better understood. But the isolated manner in which psychology has been cultivated till now, has caused its nature to be misconceived in one important respect.

The law of the association of ideas is generally mentioned as if it were an ultimate law. Now, it is no doubt an ultimate law, so far as psychology only is concerned. It is true of all mental phenomena, and it is not resolvable into any other mental law. But the phenomena of mind are only a part of the phenomena of life, and the law of the association of ideas is only a particular case, though a very important one, of a law which is true of all the phenomena of life—namely, the law of habit. In order to keep this truth before the reader's mind, I intend to speak of mental habit in preference to the association of ideas, though I admit that the association of ideas is a perfectly accurate expression, and I shall use it wherever it will best serve to express my meaning.

Impressions on consciousness are either sensory or ideal.

Ideas may be defined as all those impressions on consciousness and thought which are not due to immediate impressions of sense. All impressions on the mind, consequently, which are not sensory are ideal. This use of the word idea is perhaps rather wider than is sanctioned by common usage, but it is intelligible and, I think, necessary for the purposes of science.

Law of association stated.

The elementary law of association may be thus stated:— When two feelings have been experienced together, or in immediate succession, the recurrence of either of the feelings separately tends to recall to memory the consciousness of the other feeling; or, in fewer words and less technical language, feelings that have been experienced together tend to recall each other. Let us call two sensations, or groups of sensations, A and B; and let us call the consciousness of the two respectively a and b. If A and B have often occurred together, or in immediate succession, a and b also will have occurred together, or in immediate succession; and, in virtue of the law that all the actions of living beings tend to become habitual, a and b will acquire the habit of occurring together, and whatever produces the one will recall the other also. Or, to use an illustration instead of an algebraic statement: the sight of a man's face and the sound of his voice may become so associated together in the mind, that the consciousness, or memory, of

Instance of a man's face and his voice.

the two may acquire a habit of always accompanying each other, so that the sight of the face will recall the voice into conscious memory, and the sound of the voice will similarly recall the sight of the face. I have spoken above of "sensations, or groups of sensations." The sound of a voice is a single sensation; the impression of a man's face on the sense of sight is a group of sensations; but once a group of sensations has become familiar, it is capable of becoming the subject of associations, just like a simple sensation.

Groups of sensations.

In the case of association just mentioned, the ideas of two things become associated in our consciousness, because the things themselves have been associated in our experience by contiguity to each other, either in space or in time; and association produced in this way is called association by contiguity. Association is produced in another way, which, though quite as familiar, is not quite so easy to analyse into its elements, so as to prove it to be a case of the law of habit. I mean association by resemblance; as, for instance, when the sight of a good portrait recalls to mind the face it resembles. Association by resemblance and association by contiguity are sometimes spoken of as if they were both ultimate facts of the mental nature; but I think it can be shown that they are both to be referred to the same principle of association, though under different circumstances, and that they are both alike cases of the law of habit. In order to explain the fact of association by resemblance as a case of mental habit, it is better to speak, not of objects having the kind of likeness that a face and its portrait have to each other, but of objects so nearly alike as to be indistinguishable; as, for instance, two uncut copies of the same book. If I see a book at a friend's house, and this recalls to my memory that I have seen the same book—that is to say, a precisely similar book—in a bookseller's shop, by what mechanism of association is the recollection effected? It is to be thus explained: my first view and my second view of the book are two distinct incidents, partly alike and partly unlike—alike in that the two copies of the book were exactly similar, unlike in that the places and other circumstances

Association by contiguity,

and by resemblance,

both cases of the same principle.

Explanation of association by resemblance:

were different; and consequently the impressions produced on my consciousness by the two incidents are compound impressions, partly similar and partly different. But when the second impression on my consciousness is made by seeing the book for the second time, the idea of the book is already habitually associated with the idea of the bookseller's shop, and recalls it.

This is what takes place in all cases of remembrance by similarity. No two incidents are similar in all their details; and when they are said to be precisely similar, it is only meant that, of the compound impressions which all incidents make on the consciousness, the parts that attract the attention are the similar parts. When one thing, or one incident, recalls another by its similarity, the one, when compared with the other, may always be resolved into a similar part and a dissimilar part. Let us call the similar parts of two things, or of two incidents, A, and the dissimilar parts X and Y; the things themselves will consequently be respectively indicated by $A\,X$ and $A\,Y$. In the act by which the mind has acquired its memory of $A\,X$, A has already become associated with X as a case of association by contiguity. So that when we say the impression of $A\,X$ on the consciousness recalls that of $A\,Y$, what really happens is, that the impression of A, which is the element common to the two, recalls that of Y. Thus, association by resemblance is really a case of association by contiguity.

it is a case of association by contiguity.

In order to prevent my meaning from being misconceived, I ought to add that I regard the power of cognising resemblance and difference—in a word, the power of comparison—as an ultimate and original power of the mind, not dependent on habit, association, or memory. I have indicated this view in the last chapter. It is, for instance, conceivable that the mind should compare two sensations, such as two spots of colour, simultaneously present to the consciousness, without any element derived from habit entering into the process.

The power of cognising resemblance and difference is an ultimate fact.

Most readers who will take the trouble to follow my reasonings on the subject of association by contiguity and

by resemblance, will probably be of opinion that I have elaborately explained what is self-evident; that the subject itself may be understood without the slightest difficulty, while there is some difficulty in following my explanation of it. I reply, that, obvious as may be the whole subject when formally stated, it is not self-evident, nor, I believe, is it yet generally recognised, that all simple associations are formed by contiguity, either in place or in time; so that association by resemblance is really a case of association by contiguity. But I believe it is generally admitted that these two—contiguity and resemblance—include all cases whatever of simple association.

I must here reply to a possible objection to my mode of regarding all association as a case of the law of habit. It is beyond question that many associations, and those the most durable, are habitual; for instance, that vast network of associations between the sounds of words and their meanings which constitutes the knowledge of one's own language, has evidently been acquired by the habit of hearing and speaking the language, from a time before the earliest time that one can remember. But when we form the association between a word and its meaning, not by often hearing them conjoined but by a single mental act, as we constantly do in learning a foreign language, it may be argued that this is not a case of habit, but of a totally different mental law. I believe, however, that this difference, important as it is, may be shown to be merely one of degree. The law of habit is, that actions tend to repeat themselves. All habits no doubt strengthen with repetition; but if an action tends to repeat itself without having been repeated more than once, this is no less truly a case of habit than if it became habitual after countless repetitions. If, indeed, we knew the meaning of any words without having learned them, this would no doubt be a case of association which could not be traced to habit. But it is safe to assert that no case of the kind exists.

All association depends on habit.

In the chapter on the Laws of Habit,[1] we have seen that

[1] Chapter XV.

habits are liable to be lost by disuse. This is universally true, and it is perhaps more conspicuously true of mental habits than of any other kind. Memory, as we have seen, is altogether due to mental habit, or association, and consists in the liability of associations to be recalled into consciousness. In virtue of the law of the loss of habits by disuse, any association which remains for a sufficiently long time without being recalled into consciousness, ultimately loses the power of being so recalled; in common language, it is forgotten. But we have also seen that the tenacity of a habit does not always depend on its prominence, or present strength; and that a tenacious habit may revive after appearing to be lost. To this class of facts belongs the very remarkable yet not uncommon fact of the recollection in illness or in delirium, of long-forgotten memories of childhood.

Forgetting, a case of loss of habits by disuse.

Reappearance of memories supposed to be lost.

As the law of habit is a law of all life, so the law of mental habit, or the law of association, is a law of all mind. It enters into all mental processes. Memory, as we have seen, consists in the power of recalling associations that have been once formed. The acquisition of knowledge consists in the formation of associations: the learning of a language, for instance, consists in the formation of associations between the words and their meanings, so that either will recall the other. The acquisition of knowledge concerning things consists in the formation of associations between the various properties of the things, and the acquisition of the power of recalling those associations to memory when they are wanted. Accuracy of knowledge consists in the associations which are formed in the mind between things, and between their properties, accurately corresponding to the combinations that exist in the real world. Errors of knowledge consist in failures in the correspondence. Reverie chiefly consists in associations successively recalling each other to memory without any effort of will. Imagination, or invention, consists in the formation within the mind of ideal associations, which the inventor may afterwards construct as actual combinations

Association enters into all mental acts.

Memory.

Acquisition of knowledge.

Accurate knowledge.

Error.

Reverie.

Invention.

in the real world; as when a poem or a piece of music is written out, or a machine is constructed, after being first imagined in the mind. Reasoning consists in forming, or attempting to form, associations within the mind which will correspond to the actual combinations of things in the real world; as, for instance, when Sir R. Murchison, from the scanty data before him, predicted the discovery of that physical configuration which Dr. Livingstone afterwards discovered in South Africa.

Reasoning.

It may appear to some of my readers an inaccurate and unjustifiable extension of the use of the word, to describe imagination and reasoning as cases of association. I reply, that they are unquestionably cases of the formation of mental, or ideal, combinations; and all mental combination must be the association of ideas already in the mind; because all knowledge has its beginning in experience: the mind, strictly speaking, has no creative power, and can only combine the materials furnished to it by experience. In the present state of psychological science, I think this is unquestionable. But it does not follow that true mental originality is impossible. The mind may be truly original in its mode of combining the data of experience, just as an architect may be truly original though he cannot create the stone with which he builds, but must obtain it from the quarry.

The mind cannot create, but can only combine.

I have said that the law of mental habit, or the association of ideas, enters into every mental process except the most elementary. I think this does not admit of question. But it is a question, whether the action of the mind on the data given to it by experience, in virtue of the law of mental habit alone, is capable of accounting for all the facts of mind. This, in fact, is another aspect of the question which I have discussed in the chapter on the origin of species. I there considered the question, whether the facts of organic adaptation can be due to the actions, direct and indirect, of the surrounding world of multiform forces, acting on the organism through the laws of habit and variation alone; and I came to the conclusion that such is not the case; that, in addition to the unintelligent

Are all mental facts referable to the law of mental habit alone? Parallel question in biology.

I believe in intelligence, in

laws of habit and variation, there is a principle of organizing intelligence, which is not a resultant from any unintelligent forces, or put together out of any unintelligent elements, but is an ultimate fact of nature. Just so in the science of mind. In the present state of psychology as of physiology, the most important of all questions is whether intelligence is an ultimate, primary fact, incapable of being resolved into any other; or whether it has been put together out of unintelligent elements. I believe that in mind, as in organization, intelligence is an ultimate fact. I believe that in all thought, as in all organization, there is something for which the laws of habit do not account. But it is as yet too soon to discuss this question. I shall keep it for the concluding psychological chapter.

addition to the laws of habit.

The question stated:—Is intelligence an ultimate fact?

In the next chapter I shall have to speak of habit and intelligence as acting in the moral nature.

It will be perceived by any one who is in any degree familiar with psychological studies, that I have in this chapter treated the vast subject of the laws of the association of ideas very slightly. I have only glanced by allusion at the formation of ideas of groups of sensations, and other yet more complex ideas; to which class belong all our ideas of external things as distinguished from ideas or memories of simple sensations. And I have dismissed in a single paragraph the action of mental association in the processes of reasoning and invention; though it would take whole chapters, and perhaps a whole volume, to do justice to those subjects. My reason for doing so is, that I do not design, as part of this work, to write a complete treatise on psychology, any more than a complete treatise on biology;—and a complete treatise on the laws of association, in all their cases and applications, would be nothing less than a complete treatise on psychology. The purpose of the present work is not to enter into full detail on this or any other subject, but to point out what I believe to be the true position of the laws of habit in biology and in psychology, and the relation of the principle of intelligence to that of habit in both.

Why I have treated of association so briefly.

CHAPTER XXXII.

THE GROUNDS OF THE MORAL NATURE.

Definition. *Moral* means *emotional.*

IN speaking of the moral nature, I do not use the expression in the usual sense, in which it is restricted to those powers of the mind that take cognizance of right and wrong. I intend to speak of the moral nature as co-extensive, and indeed identical, with the emotional nature.

Moral is contrasted with *intellectual.*

The word *moral* is not properly contrasted with *mental. Moral* is contrasted with *intellectual;* and the moral and intellectual natures are both branches of the mental nature. We have seen that the intellectual nature begins from sensation, and that the first rudiment of intellect consists in the power of cognising the relations between different sensations. It is no less true that the moral nature begins from sensation. The first rudiment of the moral nature consists in cognising the difference between agreeable and disagreeable sensations, and in desiring the one and disliking the other.

The root of the moral nature is in the sense of pleasure and pain.

Pleasure and pain are inexplicable in themselves, but it may be possible to tell how they arise. Organic intelligence guides all organisms to do what is for their welfare.

Pleasure and pain—or, in other words, the agreeable and disagreeable qualities of sensations—are facts which, like sensation itself, cannot be explained or resolved into any others. But, as we have seen it to be with sensation, so it may be with pleasure and pain. Though it is impossible to explain what they are in themselves, it may be possible to tell when and how they arise. In speaking of organic intelligence I stated it to be, as I believe, the general law of intelligence, that it directs all the actions, whether formative, motor, or mental, of an organism, in whatever direction is best for the life and health of the organism.[1]

[1] See p. 8.

I am inclined to think that intelligence is in itself absolutely unerring, and that when it does not guide the actions of the organism aright, it is because the action of intelligence has been interfered with and counteracted by other and unintelligent forces: just as gravitation is a universal and unceasing force; and when bodies do not fall towards each other, it is because they are prevented. But this, as regards intelligence, does not admit of proof.

All organisms, as I believe, are intelligent, but only some organisms are sentient. All organisms, as a general rule, seek what is good for their life and health and avoid what is bad for them. Insentient organisms, as I believe, are guided in so doing by their unconscious organic intelligence; but when sensation is developed, and with it the power of discriminating between pleasure and pain, the sense of pleasure and pain becomes a guide: what is healthful is felt as agreeable, and as such is sought; what is destructive or injurious is felt as disagreeable, and as such is avoided. Not that intelligence abdicates its functions. The connexion between the animal's welfare and the sense of pleasure, and the converse connexion between injury and the sense of pain, is, I have no doubt, in some way determined by intelligence. The law that what is beneficial is agreeable, and what is injurious is disagreeable, is no doubt subject to very puzzling exceptions, of which the most remarkable, and indeed the typical, instances are the sweet tastes of some poisonous substances. These, in the present state of our knowledge, must stand over as inexplicable anomalies. But I am convinced that they are only exceptions; for, when organisms are sentient, the guidance of their lives, at least as to the choice of food, appears to be entirely committed to the sense of what is agreeable and disagreeable in taste; and if this sense habitually gave such indications as to guide the organism wrong instead of right, the whole race of such organisms would speedily perish.

Sentient organisms are guided to their welfare by sensation.

Exceptions.

Reason for thinking the law must be general.

The sense of actually felt pleasure and pain is the root of the desire of pleasure and of the fear of pain; so that,

Desire and fear.

once organisms acquire desires and fears, the law of pleasure and pain stated above causes them to desire what is favourable to their life and health, and to fear what is injurious. This is the ground of the love of life and fear of death. These feelings would be scarcely explicable if they had their roots in thought, or even in sensation; but their roots are deeper than either thought or sensation, down in the nature that we have in common with all organisms whatever, vegetable as well as animal, which prompts all alike to seek whatever ministers to their life. In other words, the impulse to self-preservation is universal among organisms, sentient and insentient, conscious and unconscious. We have become conscious, and the impulse to self-preservation has become conscious in us, and is called the love of life, or the fear of death.

Love of life.

In speaking in a former chapter of organic intelligence, I stated that organisms are guided by that intelligence to perform not only such actions as are salutary for the individual, but also such as are needed for the perpetuation and the prosperity of the race.[1] The simplest and the only universal instance of this is the reproductive function. When organisms become sentient and conscious, the actions which minister to the life of the race, as well as those which minister to the life of the individual, are attended with a sense of pleasure and become objects of desire. These feelings constitute the root of the sexual, domestic, and social affections. Thus the instinct of a bird, for instance, causes her to tend her young: she probably has a sense of pleasure in doing so; and, if she loses them, she shows manifest signs of mental pain. This is an instance of the general fact that the healthful performance of every vital function, in so far as it is attended with sensation or consciousness at all, gives rise to a sense of pleasure, and any interference with its performance gives rise to a sense of pain. The affection of a bird or other animal for her young has thus

Sexual, domestic, and social affections:

[1] See p. 9.

its root deeper than consciousness or sensation, in the instinctive intelligence which prompts all organisms, conscious and unconscious, animal and vegetable alike, to minister to the life of the race as well as to their own; and the same is true of the attachment, outlasting mere desire, which some animals, at least among birds, feel for their mates. The pleasures and pains, the hopes and fears of sympathy, all the unselfish emotions, and all that makes of man a social being, grow, I believe, out of this root.[1] So far as I see, the origin and nature of the sympathetic and social character of man neither need nor admit of any other explanation than that which is here suggested.

their roots in the organic life.

In speaking of the laws of habit, I hinted at another and totally different way in which the sense of pleasure and pain is to be directly referred to the elementary and universal laws of life. We then saw that great changes of the circumstances in which any organism has to live are injurious and destructive, while slight changes are beneficial.[2] We have subsequently seen that when organisms become sentient what is beneficial is felt as agreeable, and what is injurious is felt as painful. From these two laws, it follows by mere syllogistic inference that great changes are felt as painful, but slight changes are felt as agreeable; and this is affirmed by all experience as a general fact of our mental nature. We like familiar things and familiar ways, and yet we weary of monotony and like novelty. This sounds contradictory, yet we know that it is true. The full statement of the truth, divested of its paradoxical form, is that we like what is familiar, but we like it to be diversified with slight novelty. It does not in the least degree interfere with the truth of this statement as a law, or rather a pair of laws, of the mind, that the love of familiar things is relatively strong in some persons, and

Great changes are injurious, slight ones beneficial; great changes are painful, slight ones agreeable.

"Die Leidenschaft flieht,
Die Leibe muss bleiben:
Die Blume verblüht,
Die Frucht muss treiben."—SCHILLER.

[1] Vol. i. p. 188.

the love of novelty in others; and also that the same persons love novelty in some things, while in other things they cannot endure it. Many persons, for instance, are fond of novelty in such matters as dress and music, to whom the pain of reconsidering a religious or political opinion would be unbearable.

I should commence a perfectly inexhaustible subject if I were to endeavour to trace all the applications of this law, that slight novelty is pleasing, but great novelty disagreeable; for that law is connected with the whole subject of human character, and all the results of the action of human character in history, in art, and even in language. I shall here only speak of the importance of this principle in constituting the sense of beauty.

Application of this principle to beauty.

The sense of beauty is a very complex fact, and I believe that no definition of beauty has yet been proposed which really answers the purpose of a definition by including all that it is meant to include, and excluding all that it is meant to exclude. For the present purpose let us narrow the subject as much as possible by excluding moral beauty, such as that of a thoroughly amiable character, and intellectual beauty, such as that of the theories of gravitation and heat; so that we shall have to do with the beauty of sight and of sound alone. And let us also further narrow the subject, by excluding all elements that properly belong, not to the beautiful, but to the sublime and the picturesque, which, though they are constantly mingled with beauty, are perhaps radically distinct. Having thus narrowed the subject to beauty of sight and of sound, leaving out all elements of the sublime and of the picturesque, we shall find that it is tolerably manageable for purposes of analysis. I do not say, for I do not believe, that the complex fact of the sense of beauty is capable of being referred to any single principle of our nature. But I say that one element of beauty, and that of the greatest importance, is directly traceable to the law already stated, that slight changes are agreeable, but great changes are painful. Great changes or abrupt transitions are disagreeable to the

eye. Violent contrasts of light and shade, or of colour, are not beautiful, or at least are less beautiful than gradation. The same is true of form as of colour: a mixture of Greek and Gothic details, for instance, would be condemned by those who are best qualified to appreciate the beauty of either alone. Slight changes and gradual transitions, on the contrary, are demanded by the eye. A vast expanse of a single colour, or the endless repetition of a single form, may be beautiful, but its beauty will be of a low order: a much higher kind of beauty is due to variety of colour where the masses are not too large, as in the case of flowers among foliage; and the highest of all beauty of colour is that which is due to the almost imperceptibly graduated combinations of tints in sunset skies. The soundness of these principles is generally admitted. An artistic design in which they are observed cannot fail to have many of the elements of beauty, though it may be commonplace and unmeaning; while a design in which they are violated can scarcely be beautiful at all. I think it will be generally admitted that these artistic principles are based on our natural and instinctive liking for slight changes and dislike of great ones; and I believe I have shown how these feelings have their roots in the deepest laws of life.

I have now endeavoured to give an account of the origin of some of those feelings which are independently generated in consciousness, and transcend mere sensation. I have successively considered the love of life, the sympathetic and social feelings, and so much of the sense of beauty as consists of the love of gradual variety, or variety in unity; and I have endeavoured to trace them directly to their roots in the nature which we have in common with all living beings, whether sentient or insentient. I do not believe that their *origin* is in any way traceable to the laws of the association of ideas; though I have no doubt that the laws of association have very much to do with their *development*, as indeed they have with every mental process whatever. I am, of course, aware

Roots of emotions in the organic life.

that my view of the subject is in some degree opposed to the view held by what may now be regarded as the reigning school of British philosophy.

Emotions generated by association.

But there are feelings or capacities for pleasurable and painful emotion which are beyond all doubt generated by the action of the laws of association or mental habit. The

Association of feelings.

law of what be called the association of feelings, as distinguished from and parallel to the association of ideas, is this,—that whatever has become associated in experience with pleasurable or painful feelings, itself becomes the occasion of pleasurable or painful feelings. Thus the sight of a place where we have endured sorrow may become the cause of a feeling of mental pain, or the converse. The

Love of money;

most remarkable instance of this is the love of money. Money is not a desirable thing in itself; it is desirable only on account of the desirable things that can be had

not a primary feeling;

by its means. It is consequently impossible that the love of money can be a primary feeling. The love of food and, as I believe, the love of life, of kindred, and of at least some forms of beauty, are primary feelings, not due to association with any others, but having their roots directly in life. The love of money, on the contrary, is a secondary emotion, produced by association with the thought of the desirable things which it is able to purchase. But once it is formed, it is exactly like a primary emotion; and many men spend their lives in storing it up as if it were desirable for its own sake, without a thought of its doing any real good either to themselves or to any one else. It

may have become hereditary.

is quite probable that the love of money has become an hereditary characteristic in at least some classes of society among the civilized races of men; and if so, though it is a secondary emotion for the race, it is practically a primary one for the individual.

Emotions have their seat in the nerves of consciousness.

The seat of the emotions is, of course, not in the nerves of sensation, but in those of consciousness. This is true alike of the secondary emotions, which are generated by association, and of those which I believe to be primary, or, in other words, directly traceable to our nature as living beings, such as the love of kindred.

The sense of pleasure and pain, with the desire of pleasure and the fear of pain, constitute the germ out of which the whole of our moral and emotional nature is developed. But though they are emotional, these elements cannot be themselves regarded as moral. There are three things in which morality or moral excellence consists. These are:

Germ of the moral nature, in sensation.

1. Preferring the future to the present; or prudence.

Prudence.

2. Preferring the interest of another to one's own; the social virtues, or unselfishness.

Unselfishness.

3. Preferring a higher aim to a lower one; as, for instance, preferring the performance of a duty which is certain to be unrewarded, to pleasure; I cannot think of any word that properly distinguishes this class of virtues from the other two, except holiness.

Holiness.

In morality, as in all life, the higher is developed out of the lower, and presupposes the lower. Prudence, unselfishness, and holiness are all developed out of the preference of pleasure to pain. Out of the sense of pleasure and pain in the present arises prudence, or care to provide for pleasure, and against pain, in the future; and the readiness to forego a smaller present pleasure, or to endure a smaller present pain, in order to provide for greater future pleasure, or against greater future pain. Out of the sense of one's own pleasure and pain arises unselfishness, or care for the welfare of others. And out of the pleasures and pains, the desires and fears, of mere sensation, arise those feelings which belong to a higher order than sensation—love of beauty, love of truth, and love of virtue.

Origin of prudence: of unselfishness: of holiness.

Concerning the origin of prudence, there is no room for doubt, and not much, so far as I see, even for discussion; it necessarily arises when thought and will have obtained the ascendency over mere sensation and consensual action.

The origin of the unselfish virtues is a subject which has been very much debated. I have stated my reasons for believing that they have their roots in those instincts which prompt all organisms, sentient and insentient alike, to perform such actions as are needful for the preservation of the race.

But how have we acquired the idea of holiness? how have we learned that some pleasures, quite irrespectively of their intensity, are higher than others, and worthier to be sought—that the pleasure of hearing music, for instance, is higher than that of eating and drinking; the pleasures of the affections higher than those of music; and the pleasure yielded by the approbation of a good conscience higher than all the rest? And how have we learned to conceive of aims of duty so high, that not even the highest pleasure, present or future, ought to be weighed against them?

The sense of holiness is a case of intelligence.

I believe this moral sense, or sense of holiness,[1] is incapable of being referred to any principle belonging to either matter, life, or sensation, and can only be explained as a case, not of vital but of spiritual intelligence.

I have only glanced at this most important subject. It would be impossible to do it justice without introducing arguments drawn from another world than that external world which we know of the senses; and to do so would be to enter on a totally new class of subjects. It is not from indifference to them, but rather from the sense of their transcendent importance, that I at present pass them by with this allusion, and restrict myself in this work to the sciences of matter and life.

[1] Mr. Mill, in his work on Utilitarianism, maintains, with the whole of the philosophical school which he so ably represents, that the moral sense is what I have called a secondary feeling, and produced by association with the pleasures and pains of sensation. He is, however, obliged to admit—or rather, I ought to say, he places in the front of his theory—that besides differing in quantity (which, I suppose, means intensity multiplied into duration), pleasures differ from each other as higher and lower; a little of a higher pleasure being worth as much as a great deal of a lower one. Of course I agree with this; but I think it destroys the whole of the theory. I think it introduces an ethical element into the subject without saying whence it is derived, and thereby virtually confesses that it is underived.

CHAPTER XXXIII.

MENTAL DEVELOPMENT.

BEFORE endeavouring to trace the subject of mental development in detail, it will be well to recapitulate, so as to bring into one brief view the various statements of the last few chapters concerning the elementary principles of mind.

Mind is developed out of sensation, as out of a germ. It is the purpose of this chapter to trace the process of development.

Is sensation mental?

But does sensation itself belong to mind? I state this question, not as one which from my point of view needs any answer, but as one which may naturally arise and embarrass the reader's thoughts; and I reply to it, that the question is a purely verbal one. I have confessed my inability to frame a satisfactory definition of mind. But, as a matter of fact, mind begins with sensation. Consciousness belongs to mind; there are feelings of sensation and feelings of consciousness; I have stated my reasons for believing that the seat of both kinds of feelings is in the sensory ganglia, though produced by the action of different sets of nerves;[1] and feelings of sensation and of consciousness, especially disagreeable ones, often act on the organs of unconscious life in the same way, as for instance in the cases of nausea and of palpitation of the heart, which may be produced either by bodily or by mental feelings.

The question is only verbal.

Mind begins with sensation.

Feelings of sensation and of consciousness,

[1] See the Chapter on the Physiology of Mind (Chapter XXIX.).

or bodily and mental feelings:

I have just used the common expression of "bodily and mental feelings," to signify what I have previously called feelings of sensation and feelings of consciousness. The common expression is perfectly accurate, if we accurately understand what it really means, and do not let ourselves be hampered by preconceived notions about the mutual relation of the body and the mind. Bodily feelings are those which originate in impressions on the body; mental feelings are those which originate within the mind itself.[1]

their anatomical grounds:

To speak in anatomical language: bodily feelings, or feelings of sensation, are those which are due to the action of the nerves that connect the sensory ganglia with the various parts of the body; mental feelings, or feelings of consciousness, are due to the action of the nerves that connect the sensory ganglia with the ganglionic substance of the cerebral hemispheres.[2] But our own consciousness of our mental states unites with reasoning based on physiological anatomy, in testifying that there is no fundamental difference between the feelings of sensation and those of consciousness.

no fundamental distinction.

Sensation.

Besides sensation, we have seen that the mental functions are all to be classed under the three following heads:—

Consciousness.

1. Consciousness; to which belong the feelings of consciousness, also called the mental feelings, or the emotions.[3] Consciousness has its root in sensation.

Thought.

2. Thought; which, as I believe, has its root in the unconscious vital intelligence that belongs to all living beings. And

Will.

3. Will; which has its root in involuntary motor action.

It may be said that I have here contradicted myself, by saying in one breath that sensation is the germ out of

[1] See the chapter on the Laws of Mind, in Mill's Logic, vol. ii.

[2] I ought not to put forward an hypothesis, of which part of the details have been, so far as I am aware, first thought out by myself, as if it were a proved theory, though I am myself convinced of its truth. See the chapter on the Physiology of Mind.

[3] See Note at end of chapter.

which all mind is developed; and in the next, that consciousness has its separate root in sensation, thought in vital intelligence, and will in motor action. I reply that no such expression can be anything more than a metaphor, and that the truths indicated by the metaphors do not contradict each other, but supplement each other. Had they been indicated by inconsistent metaphors it would not have mattered, but it may be shown, if it is worth showing, that the metaphors are really consistent with each other. We may say that consciousness, thought, and will are all developed out of the single germ of sensation, but thought and will send down each its own root into the insentient life; thought into unconscious vital intelligence, will into the motor function.

Relation of thought and will to the insentient life.

I have a few more remarks to make before going on to trace the details of the process by which mind is developed out of the germ of sensation.

All development, mental as well as bodily, is differentiation; and in describing any process of differentiation, it is difficult, if not impossible, to avoid the use of language which will appear to imply that differentiation signifies *branching out*. Especially is this true when the successive differentiations are stated in a tabular form. In the tabular form to which I intend to reduce the summary of this subject, it will necessarily appear as if the various mental functions branched out of sensation, as the branches of a tree out of its root. But this, though of course only metaphorical, would be a most inaccurate metaphor. The true analogy to the differentiations that constitute mental development does not consist in the separation of the branches of a tree, which are all alike in functions and in organization. The true analogy is in that differentiation of *unlike* parts from each other which takes place in the development of all organisms, and most completely in the highest. The differentiated organs and tissues of organisms do not branch out and separate; on the contrary, the more complete is their differentiation, the more complete also is their integration; that is to say, the more unlike they become, the more perfectly their functions are combined,

Analogy of mental to organic development.

Interaction of functions in mind.

and the more necessary they are to each other's life. As stated in the chapter on the Direction of Development,[1] the more complete is the physiological division of labour, the more complete is also the physiological centralization. It is the same with the mental functions. Consciousness, thought, and will are all distinct, but they are all necessary to each other's development. Thought derives all its materials from consciousness, and furnishes consciousness with the materials of all the higher emotions. Will is directed by thought, and is nearly always accompanied by consciousness. Will has also the power of directing thought; this power is what makes possible that process of thought called abstraction, on which the immeasurable superiority of the reasoning power of man to that of all animals appears to depend. These various relations of interaction between the various mental functions are not less real, and for a complete psychology not less necessary to understand, than their relations of development; but it is only the relations of development that I shall make any attempt to state in tabular form.

I now proceed to state in some detail how I conceive the various mental functions to be derived by development the one from the other.

We have seen that the germ of all mind is sensation. Those mental functions which do not necessarily determine any other actions, but have their end in themselves, that is to say the functions of thought and feeling, have their germ in sensation determining consciousness. The voluntary powers, on the contrary, have their germ in sensation determining motor action; that is to say, in consensual action. Or we may say, using a different but not a contradictory metaphor, and stating another aspect of the subject, that thought and feeling have their roots in the sensory functions of the organism; and will, or the voluntary powers, in its motor functions.

Development of thought, feeling, and will.

It is impossible to draw the line where consensual action ends and voluntary action begins. I shall use the word

Consensual and

[1] Chapter XII.

voluntary in a sense nearly synonymous with *mentally determined*, and I shall class as voluntary all actions the impulse to which comes, as I believe, along the nerves of will; although they may not be voluntary in the highest sense, of being at our choice to do or not to do. I mean such actions as yielding to fear against one's better judgment, or attending to something that one would rather not listen to. Such actions are of intermediate character between consensual actions and those which are in the highest sense voluntary.

Voluntary actions.

Intermediate class.

The development of merely consensual or sense-determined nervous action into will is, perhaps, the greatest of the mysteries in the whole of the mysterious realm of life. I am unable to throw any further light upon it; and as the question of the freedom of the will does not fall within the province of the present work, I shall at once go on to the subject of the development of thought and feeling out of sensation.

As I have already stated, I regard the consciousness of a sensation as a distinct thing from the sensation itself; and I believe that consciousness is equally inexplicable with sensation. Without consciousness, no higher mental function than mere sensation could be developed; though thought and will are not forms of consciousness, and though they sometimes, as we have seen, act unconsciously, yet consciousness appears to be a necessary condition of their development. But the mere consciousness of sensation could not give origin to thought or emotion. I shall speak first of the development of thought, or the intellectual nature.

Sensation and consciousness both inexplicable.

The consciousness of a sensation usually—indeed, I think always—in some slight degree outlasts the sensation itself. This is memory in its simplest and most rudimentary form; and, as remarked before, it is no doubt due to some peculiar property in the nerves of consciousness.[1] This is a primary property of consciousness, and is not in any way due to thought or association. It is obvious that this much of

Development of memory, from consciousness outlasting sensation.

[1] See p. 29.

memory is necessary, in order that a number of impressions successively received by sensation should combine to make a single total impression on consciousness. The sound of a word, for instance, if it is a word of more than one letter, consists of a number of different sounds reaching the ear successively; and in order that the successive impressions on the sensation may make one practically simultaneous impression on the consciousness, it is obvious that while the mind is receiving any one of the successive impressions, it must not have lost the consciousness of those already received. The same is true of the words of any short intelligible sentence; though the words are heard successively, the total meaning of the sentence is practically flashed on the consciousness at once. The effect of this power is much more than merely to economize time in thinking; if we did not thus retain the consciousness of a sensation after the sensation itself has given place to another, it would be impossible to cognise the relation between two successive impressions, and thought—at least all thought which, like ours, is developed under the conditions of time,—thought, I say, would be, not slow, but impossible.

Necessity of this to thought.

Hearing words

and sentences.

This power of retaining impressions in the consciousness for some short time is, however, only the rudimentary form of memory. The developed form of memory consists not in *retaining* impressions in the consciousness, but in the liability of the impressions to be *recalled* into consciousness. This takes place under the law of mental habit, or the association of ideas: an impression on the consciousness recalls to memory another impression which has become habitually associated with the first; as, for instance, when the sound of a friend's voice recalls the image of his face. This, of course, is true not only of feelings of sensation, but equally so of those classes of impressions on consciousness which have their source within the mind itself. In other words, the law of memory by association is equally true of sensations, of emotions, and of thoughts. By the establishment of such associations, it becomes possible for one sensation or thought to produce not only the consciousness

Memory is developed by the law of association.

of itself, but also the revived consciousness or memory of another. Without this process, so far as I can see, thought would have no materials. And not only may one impression on consciousness call up the remembrance of another, but that remembrance may call up another remembrance; and this may go on for a great number of times. Reverie may perhaps be defined as consisting in the succession of remembered images thus calling one another into consciousness, without the guidance of thought or will. It is impossible to doubt that in a great number of cases the intermediate links of association are unaccompanied by consciousness; in no other manner can we account for the strange way in which absent and long-forgotten things will often come back to memory. This unconscious suggestion is the rudimentary and lowest form of unconscious thinking. But I have not yet come to the consideration of the thinking process.

Reverie.

The next stage in the development of memory is recollection, or the recalling of remembrances, not by the involuntary process of mere suggestion, but by a voluntary act; as, for instance, when, in answer to a request, we relate what we have heard. It is within every one's experience, that a very considerable effort of will is often needed, in order to recall what we wish to remember. Recollection is a higher development than mere memory, and, like all higher developments, it is later acquired. Children often remember tenaciously before they can recollect. This is the reason of a fact that is well known to every one who has had much intercourse with young children; namely, that they enjoy hearing a story told over and over again, even when they know it so well that they can correct any mistake in it. They *remember* the story without being able to *recollect* it. Something of the same is to be observed among uneducated adults; indeed, the power of recollection is probably in no case equal to the power of remembrance.

Recollection or voluntary memory.

Children have memory with little power of recollection.

Attention is a voluntary act; it may be defined as the voluntary direction of consciousness. It is, I think, a fact which every one may verify, that objects which

Only what has been attended to can be

recollected. have passed before the sight without being consciously attended to may be recognised when they are seen again; but only those which have been consciously and voluntarily attended to can be recollected.

We have now traced the development of memory, from the mere retaining of impressions on the consciousness, up to the voluntary recollection of them. A higher stage of what is really the same development consists in imagination, or the formation of new combinations, by the action of the mind itself, out of the materials furnished by memory. The mind cannot create; it can only recombine. Memory must furnish the materials for imagination to work on. The Greeks, in the language of allegorical fable, or rather allegorical truth, called the Muses the daughters of Mnemosyne.

Imagination.

There are thus four stages of the development of the powers of memory and imagination:—

Continuance of impressions. 1. Continuance of an impression in consciousness after it has vanished from sensation.

Memory. 2. Memory by association.

Recollection. 3. Voluntary memory, or recollection.

Imagination. 4. Imagination, or recombination of remembered impressions by the action of the mind, sometimes voluntary, sometimes involuntary and spontaneous.

Development of reasoning out of cognition of relations. Side by side with the development of the powers of memory and imagination proceeds the development of the reasoning power. As the germ of memory is the power of the consciousness to retain the impression of a sensation, after the sensation itself has vanished; so the germ of the reasoning power consists in the power of cognising the relation of different sensations one to another.

Elementary relations. There are, I believe, three, and only three, kinds of simple elementary relations between different sensations; these are:—

1. The relation of likeness or unlikeness; as when two spots of colour are perceived to be like or unlike. For brevity, let us call this the relation of likeness.

Likeness.

2. The relation of co-existence or succession in time. If

I hear the twofold note of a cuckoo, its two notes are an instance of the *succession* of two sensations in time. If I see the cuckoo while I hear it, the sound and the sight are two sensations *co-existent* in time. For brevity, let us call this the relation of succession.

Succession.

3. The relation of co-existence or separation in space. If I feel two objects, one with each hand, this is a case of the *separation* of two sensations in space. If I press one hand on a slab of marble, and find it both cold and hard, this is a case of the *co-existence* of two sensations in space. For brevity, let us call this the space-relation.

Space-relation.

Likeness, succession, and the space-relation are, I believe, the only simple and elementary relations that are possible between sensations. But I believe there is a fourth relation between feelings which is also a perfectly simple one; namely, that of cause and effect. This relation cannot exist between two feelings of mere sensation; one impression of sensation cannot cause another. But an impression of sensation may cause an emotion, as when the sight of food causes a desire to eat it; and one action of mind in emotion, thought, or will, may be the cause of another. For brevity, let us call this the relation of causation.

Causation.

All these four kinds of relation are, I believe, directly cognised by the mind; and these cognitions constitute the ground of thought. It is not, I believe, disputed by any that the cognition of simple relations is the ground and the germ of thought; but it is under discussion what relations are really simple, primary, and incapable of being resolved into others. Mill and Bain regard the relations of likeness and of succession as the only ones which are really simple; the space-relation and causation are, according to them, ultimately resolvable into the relation of succession. In the following chapters I shall have to state my reasons for differing from them; but in this I prefer only to state my belief as to what the primary relations are, and to go on with the subject of the development of the power of thought out of the cognition of simple relations.

As the power of retaining the consciousness of a sensation after the sensation itself has ceased is the germ of memory, so the power of cognising simple relations between sensations is the germ of thought. It is to be observed that the cognition of simple relations is presupposed in the formation of associations of ideas. Association by contiguity presupposes that the mind cognises the relation of contiguity, whether in space or in time; and association by likeness, in the same way, presupposes that the mind cognises the likeness. This is equally true, whether I am right or not in believing that association by likeness is resolvable into association by contiguity.

Relations presupposed in association.

The first stage in the development of thought is thus the cognition of relations: the second is the perception of things. I think that Berkeley has clearly proved the act of perceiving things to be, not an immediate and simple act of the mind, but an inference from data; the data being sensations, and the relations between sensations. It may be advanced as an argument against this, that insects appear to perceive, and yet they are without the cerebral hemispheres, which in the Vertebrata are the organs of thought. I reply that perception, though an inference, and as such an act of thought, is not due to conscious thought, but to unconscious, though sentient, organic intelligence. The thought which I believe to have its seat in the cerebral hemispheres is conscious thought, or, if it has become unconscious, it has had its origin in consciousness. But the sensory ganglia are perhaps the seat, not only of sensation, but of the power of cognising likeness, succession, and the space-relation between sensations; and in insects, and possibly even in the Vertebrata, they are the seat of perception also. In a future chapter I shall have to treat the subject of perception with greater fulness.

Perception.

Perception may have its seat in the sensory ganglia.

In the development of thought, the next stage above perception is that lower form of the reasoning power which we have in common with animals. This may be defined as merely reasoning from one object of sense to another, or

simple inference; it consists in the power of making such inferences as this, that a man must be in the house because his hat is on its peg.

The next stage of the development of thought consists in the distinctively human power of reasoning. I am not able to see any way of referring all the superiorities of man to any single principle. But so far as the superiority of man to the highest of the animals is intellectual, I believe it is traceable to the fact, that man has the power, which they have not, of directing his thoughts at will. On this power depends the power of abstraction; and with it the power of using words and other arbitrary signs in speaking and in thinking.

Man's superiority in reasoning.

Power of directing thought at will. Language. Abstraction.

It was a favourite doctrine with Archbishop Whately, that "language is not only the expression of thought, but the instrument of thought;" and he maintained that it is impossible to carry on any reasoning process except by the aid of words or other arbitrary signs of essentially the same kind, such as the figures of arithmetic or the letters of algebra. And I believe he maintained in connexion with this, and as part of the same theory, that the power of using such arbitrary signs as instruments of thought is the distinctively human power, and is at the root of man's intellectual superiority to the lower animals.

Whately's view on language.

There can be no doubt that this is correct as to the facts. It is possible to make such an inference as that a man must be in the house if his hat is on the peg, without the use of words in the process; and there are many dogs which are perfectly able to draw such an inference as this. But no one who examines any reasoning process of a much higher kind than this, as it goes on in his own thoughts, will doubt that we think in words; and that if we were debarred from the use of words in thinking, no elaborate process of thought would be possible to us. But I cannot believe the power of making use of words or other arbitrary signs for the purpose of thinking, to be an independent and primary power. I think it is the result of something simpler and deeper. I should think so, even if

Use of words in thought.

I were myself unable to carry the analysis any further. But I believe it is a result of another power, which constitutes the really primary and fundamental difference between the intellect of man and that of the animals which most nearly approach him; namely, the power of directing thought at will. Thought is impossible without the formation of associations: indeed all thought which is higher than the cognition of the simplest relations consists in forming new associations. In forming associations the mind is at first purely passive; but it soon becomes active, and one of the most important results of its activity is the formation of language; which consists in the formation of arbitrary associations between the words and their meanings, by a voluntary, though probably only half-conscious, act of the mind. A second result of the power of directing thought at will is the power of abstraction. Without abstraction none but the most rudimentary process of thought would be possible. An example may best serve to make this subject clear, and the best example I can think of is that contained in elementary arithmetic. The multiplication table is the statement of a set of abstract truths—truths, that is to say, which can only be arrived at by abstracting, in thought, the relations of number from the ideas of all the things that are or can be numbered. In saying that eight times eight are sixty-four, for instance, we have nothing to do with any things that may count up to the number of sixty-four; they may be books, or cattle, or houses, it matters not: we only make an assertion concerning the abstract numbers eight and sixty-four. Thus in thought and in language to abstract a particular set of the relations, or of the properties, of things from the things themselves, is what mere suggestion, working by the laws of association, could never do; only a voluntary act of the mind can do it.

due to the power of directing thought at will:

whence also the power of abstraction.

Instance in arithmetic.

In reasoning as well as in memory, the voluntary action of the mind is a later and a higher development than its spontaneous action. Voluntary recollection is higher than spontaneous remembrance, and voluntarily directed thought is higher than spontaneous thought. The same is also true

Voluntary action is always later developed than involuntary.

of motor action: voluntary motor action is a later and higher development than consensual action.

Simple inference and abstract reasoning.

The lower kind of reasoning, which we have in common with animals, and which merely consists in reasoning from one object of sense to another, may be called simple inference. The higher and distinctively human kind may be called abstract reasoning.

I have now completed this outline of the development of the intellectual nature; and concerning the development of the moral and emotional nature it is only necessary to state again, in a slightly different form, the results we have arrived at on this subject in the preceding chapter.

Moral nature developed out of the sense of pleasure and pain.

Care for the future.

Emotions due to association.

The germ of the whole moral and emotional nature is the sense of pleasure and pain in mere sensation. Out of the sense of pleasure and pain as actually felt, arise desire and fear; and out of the desire and fear of present things, such as desire for food or fear of a wild beast, arise care for the unseen and distant future; and hence the virtue (for it is a virtue) of prudence. At the same time new emotions are produced by the action of association, which attach themselves, not to the immediate pleasures and pains of sensation, but to objects which have become habitually associated with these. The love of money is the best instance of this; it has evidently been produced by the association in the mind of money with the desirable things that money can obtain for its owner; for money is not desirable except on account of the desirable things it will obtain. Selfish as this passion usually is, it is the mark and attribute of a more highly developed mental nature than that which cares only or chiefly for the enjoyments of mere sensation. I have mentioned the love of money, because it is by far the most remarkable of the class; but these feelings of association may attach themselves to almost anything, and sometimes do attach themselves very closely to places and to objects which may have no beauty, and no value except as mementoes.

Sympathy.

Next in the scale of moral development are sympathy and the social affections. Out of the desire of good and

the fear of harm for oneself, arise the desire of good and the fear of harm for others. This among animals appears to be confined to the care for offspring, and the sympathy of gregarious animals of the same flock for each other; but in man it becomes the root of patriotism, philanthropy, and all the unselfish virtues.

The last and highest kind of moral development consists, in its rudimentary form, of those affections which are not to be referred, either directly or (as I believe) indirectly, to the pleasures and pains of mere sensation: the most important of these are the love of beauty and the love of knowledge. Higher than these, but on the same line of development, is the moral sense—the love of holiness, and the fear and hatred of sin.

Love of beauty, of knowledge, and of holiness.

I have now, in conclusion, to enumerate in tabular form the various kinds, or rather the various directions, of mental development, with the successive stages of each. I do not think it at all likely that my enumeration can be nearly perfect—I have no doubt it will be found to admit of great improvements in detail; but I am convinced of the substantial correctness of its plan. The main divisions —those which are marked with Arabic figures—are, I believe, entirely right. They differ from each other not in degree but in kind, and may be compared—to use an illustration which is quite accurate for the present purpose —to the branches of a tree. The subdivisions—those which are marked with Greek letters—may, no doubt, be greatly improved in detail, especially those of the emotional part. The successive subdivisions of the same division differ in degree rather than in kind; they are, at least in several instances, successively developed out of each other, and may be compared, not to distinct branches, but rather to the successive parts of the same branch. It will be seen that the principle of this table is the same as that in the chapter on Organic Functions[1]—of which, indeed, it may be regarded as a continuation. The arrangements of the subjects in the two tables are not quite consistent

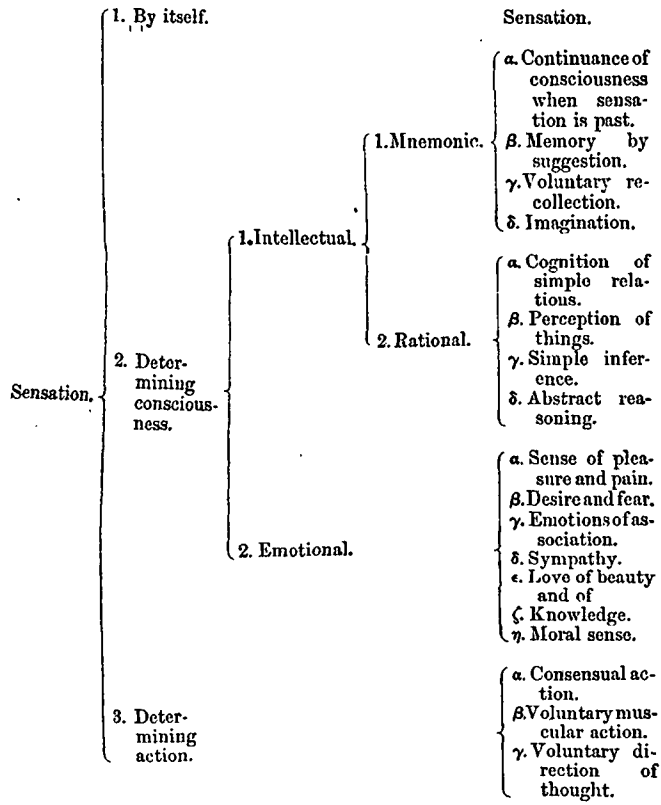
[1] Vol. i. p. 163.

with each other; but this is not any proof of inaccuracy: I have endeavoured to make each separately accurate from its own point of view.

As the use of a tabular statement like this is not to communicate information or ideas in the first instance, but to give a concluding summary of them, it may be well first to state its substance in an ordinary paragraph.

Summary. Sensation may produce no effect beyond itself, or it may produce consciousness, or it may produce action. Consciousness is either intellectual or emotional. The intellectual nature has two distinct developments; one in the direction of memory and imagination, the other in the direction of the reasoning power. The germ of memory is the continuance of the consciousness of sensation after the sensation itself has ceased: this successively develops into memory by suggestion, voluntary recollection, and imagination. The germ of the reasoning power is the cognition of such simple relations as likeness, succession, and the space-relation: this successively develops into perception of things, the power of simple inference, and the power of abstract reasoning. The germ of the emotional nature is the sense of pleasure and pain in mere sensation: this develops into desire and fear; the emotions due to association, such as the love of money; the sympathetic emotions; the love of beauty and of knowledge; and the moral sense, or sense of holiness. When sensation produces action, this in its simplest form is consensual action: it successively develops into the voluntary direction of muscular action, and the voluntary direction of thought.

Tabular statement.



The foregoing table represents the development of the mental functions alone from the germ of sensation. The following one is an extension of the tabular statement of the organic functions in the chapter on that subject.[1] As given there, all the functions which are developed out of sensation were included under the single head of Mind: I now state them separately, and classified from the point of view of development.

[1] Chapter XV.

- 1. Formative or vegetative functions, essentially consisting in the transformation of matter.
  - 1. Chemical.
    - Formation of organic compounds.
    - α. Formation of tissues.
    - β. Formation of organs.
  - 2. Structural.
- 2. Animal functions, essentially consisting in the transformation of energy.
  - 1. Motor.
    - α. Spontaneous motion.
    - β. Reflex motion.
    - γ. Consensual motion.
    - δ. Voluntary motion.
  - 2. Sensory.
    - 1. Sensation determining only itself.
      - Sensation.
        - α. Continuance of consciousness when sensation is past.
        - β. Memory by suggestion.
        - γ. Voluntary recollection.
        - δ. Imagination.
      - 2. Sensation determining consciousness.
        - 1. Intellectual.
          - 1. Mnemonic.
          - 2. Rational.
            - α. Cognition of simple relations.
            - β. Perception of things.
            - γ. Simple inference.
            - δ. Abstract reasoning.
        - 2. Emotional.
          - α. Sense of pleasure and pain.
          - β. Desire and fear.
          - γ. Emotions of association.
          - δ. Sympathy.
          - ε. Love of beauty and of knowledge.
          - ζ. Moral sense.

Second tabular statement.

NOTE.

IN the past chapter, wherever I have spoken of emotions—that is to say, feelings of consciousness (or, to use Herbert Spencer's expression, feelings which are independently generated in consciousness, as distinguished from mere sensations);—where I have spoken of emotions, I say, I have always implied that the emotion itself and the consciousness of the emotion are one and the same thing. I have, nevertheless, insisted that the consciousness of a sensation is a distinct thing from the sensation itself, and that the consciousness of a thought is a distinct thing from the thought itself. I refer to this, as it may probably be thought that I have fallen into an inconsistency out of mere inadvertence. I believe, however,—though I hold the opinion subject to reconsideration,—that I am right: I believe that sensation and thought may, and do, exist without any consciousness of them, but that there can be no emotion, or mental feeling, without the consciousness of it. It may be urged that, as a matter of experience, there are unconscious emotions as well as unconscious sensations and unconscious thoughts. It is a common remark to make of those we have loved and lost, that we did not know the strength of our own affection till its object was gone. I think, however, that in such cases what we were formerly unconscious of was not any feelings which we *had at the time*, but the feelings which we *should have* under changed circumstances; and though I believe we cannot be unconscious of actual feelings, there is no doubt we may be unconscious of possible feelings, which may under changed circumstances become actual.

There are unconscious sensation and thought.

I believe there is no unconscious feeling.

CHAPTER XXXIV.

MENTAL GROWTH.

IN the last chapter, I have given an account in outline, of the process by which the mind, like an organism, is developed by differentiation out of a simple germ. The organism is a mass of vitalized matter, having very complex structure, and is developed out of a minute structureless mass of gelatinous substance. The mind is a complex aggregate of conscious and intellectual functions, and is developed out of the germ of sensation. The resemblance is one of analogy, according to the received definition of analogy, namely resemblance of relations. The mind does not resemble a bodily organism, but the relation of the mental functions to each other resembles the relation to each other of the bodily functions and of the bodily tissues and organs. And this analogy, or resemblance of relations, between the functions of the mind, and the organs of the body, is twofold. They not only agree in the vast complexity of both being developed by differentiation out of a simple germ; they further agree in this, that as in organic development the more complete is the differentiation, or mutual separation and unlikeness, between the various organs, the more complete also is their integration, or mutual co-operation and dependence; so in mental development: the more complete is the differentiation of mental functions from each other, the more complete also is their integration. As an instance of this mutual dependence, or integration, of mental functions, may be mentioned the fact that pure

Analogy between the organism and the mind in development by differentiation.

Organic and mental integration.

scientific thought, perfectly differentiated from feeling, needs the action of will to make it work.

Analogy of organic and mental growth.

The analogy here traced is between the mental functions and the bodily organs. I do not lay claim to any originality in pointing it out. But there is a further analogy, between organic growth and mental growth, and between the formation of organic tissue and of what by a bold metaphor may be called mental tissue; which, so far as I am aware, has not yet been traced by any one in all its closeness.

The organism is constructed out of the food by the organic intelligence:

It is a well-known truth, that every organism is built up out of the substance of its food. This is perfectly familiar with respect to animals, and is equally certain of plants, though their food is less visible, consisting chiefly of the carbon contained in the carbonic acid of the air. But this is evidently not a full account of the process of nutrition. There must be not only materials, but something that builds with the materials; and this something is the principle of life, or the organizing power, which, as I have stated my reasons for believing, is intelligent, though unconscious.[1]

so mind is constructed out of impressions of sense by the mental intelligence.

The growth of mind is analogous with this. As all materials come to the organism from without, so the materials of knowledge come to the mind from without, in the shape of impressions on the senses. All knowledge begins with sensation; we have no "innate ideas:" previous to sensation we have neither ideas, nor knowledge, nor any actual mental existence whatever, but only the possibility, or to speak more accurately the potentiality, of a mental existence. This is admitted by all. To quote the old scholastic axiom, "There is nothing in the mind but what it has derived from sensation." But this is evidently not a full account of the process of mental growth. There must be not only materials, but something that builds with the materials. As Leibnitz expressed it, we must modify the scholastic axiom, and say: "There is nothing in the mind but what it has derived from sensation, *except the mind itself.*" From the point of view to

[1] See the chapters on Natural Selection and on Intelligence.

which we have now attained, this axiom may be thus amplified:—"There is nothing in the organism but what it has received in the food, except the organizing principle of vital intelligence which builds up the organism; and there is nothing in the mind but what it has received from sensation, except the organizing principle of mental intelligence, which evolves knowledge out of the materials received from sensation." It is my belief that the organizing intelligence of the vital organism, and the intelligence of the mind, are one and the same principle, though acting unconsciously in the organism and consciously in the mind: and further, that this intelligence, under both of these its manifestations, is an ultimate fact, incapable of being resolved into anything simpler than itself.

I have not yet, however, fully stated the closeness of the analogy between organic growth and mental growth. The living organism, while it is constantly acquiring and assimilating new material, is as constantly parting with old material. These two processes respectively constitute nutrition and waste; and the excess of nutrition over waste constitutes growth. Waste is most rapid in the early youth of an organism, but at that period nutrition is more rapid still, and consequently growth is most rapid in early youth. The process of mental growth is an exact parallel to this. The mind is constantly receiving *im*pressions from the external senses, and as constantly losing the impressions by forgetting them; old impressions on the memory fade away and are lost, and new ones supply their place; and mental growth consists in the excess of what is remembered over what is forgotten: mental growth goes on so long as the new impressions which are retained exceed in number, force, and variety those which are lost. As organic growth consists in the organism acquiring more substance than it parts with, so mental growth consists in the mind acquiring more and stronger impressions than it loses.

Assimilation and waste:

both most rapid in youth.

Parallel in receiving and forgetting mental impressions.

Organic and mental growth: both consist in excess of what is received over what is lost.

This, when once distinctly stated, is self-evident; but the parallel is closer still. Waste, no less than nutrition,

Waste is a condition of organic life:

is a necessary condition of organic life and growth. The organism is not like a crystal, which simply acquires substance, and, when it has done growing, remains in a state of molecular immobility. Both during growth and after growth has ceased, the organism is constantly losing substance and replacing it with new substance. Every one is aware that this is true of the organism. Every one knows that waste is not an imperfection of the organism, as wearing-out is of machinery, but a necessary condition of life. But it appears to be the general belief, that the corresponding fact in mental life—the liability to lose impressions by forgetting them—is an imperfection and a weakness of mind, as liability to wear and tear is of machinery. I am convinced that this is an error; I am convinced that as waste, no less than nutrition, is necessary to the life and growth of the organism, so forgetting, no less than remembering, is necessary to the life and growth of the mind. This may appear a strange paradox, but I think that on consideration it will become evident.

so is forgetting of mental life.

If we remembered all the mental impressions we had ever received since the beginning of our mental life, we should be distracted by their multitude, we should be overwhelmed by their weight. If the sound of every word of our own language, or of any other language with which we have become familiar, were to recall to memory every time we had ever heard it pronounced; or if the sight of every familiar face were to recall every time we had ever seen it; if all details, the most insignificant as well as the most important, the least interesting as well as the most interesting, were to come crowding unbidden into memory whenever we desired to think of any object or of any event,—the mind would, as it were, have no room to move, and thought would be impossible. But such a result is prevented by that constitution of the memory in virtue of which we retain, generally and on the average, the important and interesting particulars of any object or of any event, and forget the rest; so that, on the whole, we retain what we need to retain, and forget what we do best to forget.

If we remembered everything, we could not think.

Further; the greater part of our mental acquisitions does not consist of mental pictures of single objects, or mental representations of particular events. Such pictures and such representations are not formed until memory develops into the power of recollection, and it is not probable that animals or young children form them at all. The most important mental acquisitions, and those the accumulation of which constitutes the rapid mental growth of young children, do not consist of the residua[1] of single impressions, but of the coalesced residua of many impressions. An impression leaves its residuum in the memory; and when it is often repeated, the residua of the several impressions become inseparable and indistinguishable, and coalesce into one. It is in this way that we become familiar with the words of our own language, and with everything else that is familiar; indeed, it is part of the definition of familiarity, that we are not familiar with anything until we have forgotten how often we have witnessed it. The earliest, the most durable, and the most important of our mental acquisitions are of this kind. The best instance of this is, perhaps, our knowledge of our own language. We have become familiar with words in common use, not by hearing them once, but by hearing them oftener than we can remember; our knowledge of any common word is not a single residuum from the impression made by hearing it once, but a coalesced residuum, consisting of the indistinguishably united residua that have been left at each time we have heard it. Familiarity with a word consists of two elements, familiarity with its sound and familiarity with its meaning. The sound of a word is only an impression on the sense of hearing, but the knowledge of the meaning consists of a mental association, effected in virtue of the law of habit, between the sound and the thing which it signifies. In order that language should rightly fulfil its function of communicating thought, it is necessary that every word shall suggest its meaning;

Coalescence of residua by forgetting.

What constitutes familiarity.

Words must not only suggest

[1] I borrow the word "residuum" from "Morell's Mental Philosophy." He has borrowed it from the German writers on psychology. I make no apology for the use of a most convenient though new word.

their meaning: they must suggest nothing else.

but more than this is needed; it is further necessary that every word shall suggest nothing else. The requisite that a word shall suggest its meaning is secured by the power of memory: the requisite that it shall suggest nothing else is secured by the not less necessary, though purely negative, power of forgetting. The sound of a word may have been heard a thousand times, under circumstances which were never exactly alike; the speaker, the words before it in the sentence, the words after it, and all other circumstances, have been constantly varied, excepting only the only important circumstance (using the word circumstance with its literal signification), the circumstance of its meaning. In virtue of the law that strong or often-repeated impressions on the consciousness leave residua in the memory, the word itself and its meaning are remembered; in virtue of the law that feeble or seldom-repeated impressions on the consciousness fade altogether away, the varying and unimportant circumstances under which the word has been heard are forgotten. Of all the complex impressions which have been produced on the mind by the word, as it has been heard a thousand times under as many partly dissimilar circumstances, the varying and unlike elements are forgotten, while the constant elements—that is to say, the sound of the word and its meaning—are retained; and the residua of the thousand impressions, having become alike by the loss of their unlike elements, are indistinguishable, and coalesce into one. By this process, the word comes to remain in the memory, separate, detached, suggesting its meaning, and suggesting nothing else. But if the residua of all the thousand impressions did not lose their unlike elements, they would still be distinguishable, and could not coalesce into one. The word would indeed remain in the memory, but not as a single coalesced residuum; it would not be separate and detached from irrelevant objects: it would no doubt suggest its meaning, but it would suggest so much else that it would not serve the purpose which language is meant to serve.[1]

The first of these is secured by remembering, the second by forgetting.

[1] It may be objected to this, that, in learning a foreign language, we habitually remember a word and its meaning after meeting with it only

I will now sum up the whole of the parallel I have been endeavouring to draw between organic and mental life and growth. Summary.

The organism grows by means of new material brought from without in the food. So the mind grows by means of impressions brought from without by the senses. But food could not of itself build up an organism. The organism is built up out of the materials of the food, by the action of the intelligent organizing principle of life. So the impressions received by the mind from the senses could not of themselves form a mind. They are organized into knowledge, and become part of the mental structure by the action of the intelligent principle of mental life.

It is necessary to organic life and growth not only to be constantly acquiring new material, but also to be constantly parting with old material. So it is necessary to mental life and growth to be not only always acquiring and retaining new impressions, but always also forgetting.

Organic growth is due to the excess of material acquired over material parted with. So mental growth is due to the excess of what is remembered over what is forgotten.

In infancy, when the body is growing most rapidly, it is also most rapidly undergoing waste and parting with material. So in childhood, when the mind is acquiring knowledge the most rapidly, it is also forgetting the most.

The same law of forgetting, and the necessity of forgetting, are true of a different though closely related set of mental phenomena. I mean the process by which habits of action are formed. "We learn to do a thing by doing it." The process of learning a mechanical art is this: that actions are at first performed voluntarily and with conscious attention; but, in virtue of the law of Formation of habits of action by the same law.

once. But this is an acquired power. Partly through mere habit, partly through voluntary exertion, the student of a language acquires a power of forming the association between a word and its meaning with peculiar facility. I think that children begin to acquire this power while they are learning to speak. But it is not likely that a trace of it exists at the time when language is nothing to the child but sound; and yet every one's knowledge of language has to begin from that point.

habit, the oftener they are repeated the easier they become, until at last, in many cases, they cease to need any co-operation of the will or of the conscious attention. They have of course to be voluntarily set going, but when set going they are continued consensually; the stimulus and guide to each successive action of the muscles being sometimes the action next before it, sometimes the sight of the work or the instrument before the workman. Some musicians become able to perform in this way, the stimulus of sense being given either by the sound of the successive notes, or by the sight of the printed music. I have stated this before, but what I wish to point out now is the perfect similarity between this process and the process by which we learn our own language; or, in more general terms, between the process of acquiring motor habits, and the process of acquiring purely mental associations. I have shown that, in order to have the association between words and their meanings in an available form in the mind, the residua of the impressions of all the times we have heard any word must coalesce in the mind into a practically single residuum; and this is done by forgetting the merely accidental circumstances under which we have heard each word. Just so in learning an art. Before it can be consensually performed the memory of each separate time that it has been practised must be lost, and the residua of them all must coalesce into one, which single residuum constitutes the acquired habitual power.

Moral benefit of forgetting.

The necessity under which we are of forgetting is good for us in another way. Our life and our duties are in the present, and it would be bad for us were our thoughts to be too much in the past; but this is for the most part forbidden by the law of the certain though slow and gradual fading away of all impressions which are not renewed. It is in virtue of this law that time mitigates grief, even when no nobler cause is at work.[1]

[1] "We forget because we must,
And not because we will."
MATTHEW ARNOLD.

Forgetting is a case of the laws of habit.

It is to be observed that the law of the fading away of mental impressions is not an independent primary law. It is a case of that law of habit in virtue of which all vital tendencies, whether organic or mental, gradually disappear when nothing occurs to call them into exercise.[1]

[1] See the chapter on the Laws of Habit (Chapter XV.).

CHAPTER XXXV.

THE SENSES.

IN the foregoing chapters it has not been necessary to speak of sensations and the consciousness of them further than as general facts: there has been no occasion for discriminating between the various kinds of sensations. But before entering on the consideration of the complex facts of perception, and of our conceptions of time and space, it will be necessary to consider the peculiarities of the various senses, and of the various ways in which they are related to the mind. For the analysis of the more general facts of mind, it is only necessary to take into account the general fact of sensation; but for the analysis of the more special facts of mind, we must also take into account the special facts of the various senses.

It is not necessary in the present chapter to make any further mention of the visceral sensations, such as hunger and thirst, and the sensations of being well or ill. For the present purpose we have to do only with the external senses; that is to say, those senses by means of which we obtain information concerning things external to the sentient organism.

External senses. That of heat is distinct. The muscular sense belongs to touch.

The external senses are usually enumerated as five; namely, touch, taste, smell, sight, and hearing. The sense of heat, however, is really a distinct sense, though it has its seat in the same nerves with the sense of touch. The "muscular sense," or sense of muscular action, is classed by many as a distinct sense; but I shall state my reasons for regarding it as not really separable from the sense of

touch. Perhaps, however, this is little else than a merely verbal question.

There are several different ways in which the various senses differ very remarkably from one another. These differences I shall now proceed to enumerate.

1. The nerves of the skin are both nerves of touch and nerves of the sense of heat; and the nerves of the inside of the mouth are nerves at once of touch, of the sense of heat, and of taste. These, though combined in the same nerves, are distinct senses; and when the same nerve is transmitting sensations of distinct senses to the sensory ganglia, they are cognised by the consciousness as distinct sensations. Thus, if we are eating something which is hard enough to press against the inside of the mouth, which is hot, and has a flavour, the pressure, the heat, and the flavour form, not one combined sensation, but three distinct sensations. But when two or more sensations of the same sense are transmitted by the same nerve, the sensations, instead of being cognised as distinct, combine into a resultant sensation, which makes a single impression on the consciousness. Thus, if two tastes, or two smells, are mixed together, the mixture is perceived as a single taste or smell, having a character intermediate between those of its constituents; but it is impossible to direct the attention to one of the two constituents separately. In drinking tea with sugar in it, for instance, the sensation is a mixed sensation, and not two sensations; and it would be impossible, by any effort of attention, to taste the tea and not the sugar, or to taste the sugar and not the tea. The same is true of mixed colours. If two rays of light of different colour are made to combine their colours by falling on the same spot of white paper, what is seen is not two colours, but a resultant colour. If red and yellow, for instance, are thus combined, the resultant colour is orange; and it would be impossible, by any effort of attention, to see either the red or the yellow separately. In some cases, of which that just mentioned is one, the resultant colour is of a character intermediate between those of its constituents; but when all the prismatic

The skin-nerves are nerves of both touch and heat; as are also the nerves of taste;

and these sensations do not combine with each other:

but two tastes or smells, when mixed, combine into a resultant of character intermediate between their constituents.

So of mixed colours.

Orange.

White. colours are combined, the resultant is white, which is totally unlike any of them, and could not possibly have been predicted from them.[1] The sense of hearing is the only one among the senses which has any power of cognising, as distinct, sensations of the same order which come mixed together. We have a power of distinguishing simultaneous sounds, and even of directing the consciousness, by a voluntary act of attention, to one sound among many; thus, any one can, by a little effort of attention, hear what a particular person is saying amidst a buzz of conversation; and some persons acquire the power of listening to a single instrument in a whole orchestra. This is no doubt an acquired power—that is to say, it is not likely that infants are born with it; but it is a power which is not the less characteristic of the sense of hearing; no amount of practice would give to the eye the slightest vestige of any power analogous to this;—no practice could confer the power of seeing any of the separate prismatic colours in white light. There is reason, however, to believe that the sense of hearing is no exception to the law that sensations of the same sense, when transmitted by the same nerve, combine into a single sensation. There is reason to believe that distinct sounds are not transmitted to the auditory ganglia by the same nerve, but that on the contrary sounds of different pitch excite each a different nerve. I shall have to return to this subject.

Sounds do not so combine,

but may be discriminated.

Reason of this in the constitution of the nerves of hearing.

I think there are no cases of sensations of different senses being transmitted by the same nerves, except those already mentioned, of the nerves of the skin being at once nerves of touch and of heat, and those of the mouth being at once nerves of touch, of heat, and of taste. The nerves of smell, of sight, and of hearing appear to transmit no sensations except those which are peculiar to them.

The nerves of smell, sight, and hearing transmit no other sensation.

As stated above, I believe it is a law that when the same nerve transmits two or more sensations of the same sense, they combine into a single sensation; but when the sensations transmitted by the same nerve belong to distinct senses, they are cognised as distinct. I think we may with

[1] On the laws of the combination of colours, see Note at end of chapter.

some degree of probability assign a physical ground for this law. We have seen in a former chapter,[1] that in nervous action something flows along the nerve-fibre with a measurable velocity much less than that of the electric current along a wire. It is scarcely possible to doubt that what thus flows along the nerve, as well as what flows along the electric wire, is not a fluid, or matter in any form, but energy, in the form probably of a vibratory or wave-like motion of the molecules of the conducting fibre. Now when waves are formed in the same medium and of the same order of magnitude, they combine into resultant waves; but if the waves formed in the same medium are of different orders of magnitude, they do not combine, but remain visibly distinct. Thus, if two stones of nearly the same size are thrown into water at a little distance from each other, the waves raised by the two will, where they meet, be seen to coalesce together, though they afterwards separate; but if the waves from a stone are met by the waves proceeding from heavy drops of rain, the two sets of waves, being of different orders of magnitude, will remain visibly distinct, though intersecting each other. If it is true that sensation is due to the transmission of vibrations along the nerve-fibres to the ganglia, it appears a probable conjecture that sensations of the same sense are due to vibrations of the same order of magnitude, and sensations of different senses to vibrations of different orders of magnitude; and that vibrations of the same order, when coming into the sensory ganglia together, combine and produce resultant sensations; while those of different orders do not so combine. But I only offer this as a conjecture, which I see no possible means of verifying.

Probable cause of sensations of different kinds being transmitted by the same nerve without combining.

2. The perception of space is due to the senses of touch and sight exclusively: no other sense is capable of giving it. I shall have to examine this subject in detail in the next chapter, where I shall state reasons for believing that our first cognition of space is due to touch, including the muscular sense, though our habitual thoughts of space have become associated rather with sight.

Only touch and sight give perception of space.

[1] See the chapter on the Direction of Development (Chapter XII.).

Intellectual senses: touch, sight, and hearing.

3. There are only three of the senses which can be regarded as in any way intellectual senses—I mean, as ministering to the intellect; these are hearing, sight, and touch. By hearing we learn the thoughts of our fellow-men, and by sight we obtain the greater part of our knowledge of external things. In the developed state of the intellect, we make progress in knowledge by means of these two senses exclusively; but at the beginning of intellectual development, touch is probably the most important of all; for, as I shall have to show in the next chapter, it is in all probability by means of touch that we acquire our first cognition of space, and with it our first knowledge of the existence of an external world.

Reproduction in memory of impressions of sight and hearing.

Pleasure due to this.

Its moral importance.

4. In connexion with the intellectual character of sight and hearing is the fact that they are the only senses the impressions of which are capable of being reproduced in recollection with any vividness. It is often easy to recall in thought what we have seen or heard, to recall an absent face or scene before the mind's eye, or to repeat in thought a conversation or a poem. This power is often a source of very great enjoyment, especially to intellectual persons who lead a lonely life; and its usefulness needs no proof: but what is not quite so obvious is the moral importance of this fact. These "pleasures of memory" are perfectly pure, and of a kind that are good for the mind. But if it were possible to recall pleasures of the unintellectual senses in the same way, and to enjoy them in the recollection; if it were possible, for instance, to feel the same kind of reproduced pleasure in the memory of the meat we have eaten and the wine we have drunk that we can feel in the memory of the music we have heard and the pictures we have seen, it needs no proof how bad this would be for human character. And further: many of the pains produced by disease or accident are very intense, and would embitter life if they remained in the memory; but, like the pleasures of eating and drinking, and all other unintellectual impressions on the consciousness, these pains cannot be reproduced in consciousness, and are comparatively forgotten.

The facility of recalling the impressions of sight and sound is the basis of the imaginative power, which, in so far as it works with the materials of sense, works exclusively with those of sight and sound, and produces the results which we enjoy in music, in painting, and in the rest of the arts.

Cause of this in hereditary habit.

The cause of the facility of recalling the impressions of sight and sound is, I have no doubt, hereditary habit. Ever since the first dawn of the human intellect, men have been endeavouring to recall the words they have heard from other men, in order to consider their meaning and what they indicated; and they have been endeavouring to recall what they have seen, in order to decide where to go and what to do. The power of reproducing sights and sounds in memory has thus been cultivated by practice, and has become hereditary. But no power could be developed by habitual exercise, unless its germ existed previously. The germ of memory, as shown in the chapter on Mental Development, consists in the consciousness of a sensation outlasting the sensation itself; and the next stage of its development consists in the power of remembering a past sensation when it is recalled by anything that has become associated with it. In connexion with the visceral sensations and the unintellectual senses, the development of memory stops here: in connexion with sight and hearing, it goes on into recollection, or the power of recalling impressions at will for the purposes of use and enjoyment. And this, again, becomes the germ of imagination.

At the risk of some repetition, I shall now enumerate the different senses, with the principal characteristics of each.

Senses of touch and heat.

1. The nerves of touch are also nerves of heat, but, the senses being distinct, an impression of touch and one of heat occurring together are cognised in consciousness as distinct: for instance, if I press my hand on a slab of marble and feel it hard and cold, the hardness and the coldness are cognised as distinct sensations.

These sensations do not combine.

The sense of touch consists in the sense of pressure and

What touch cognises is resistance.

resistance: all the properties of things that we cognise by means of touch, such as the differences of hard and soft, and of rough and smooth, are due to various modes and degrees of resistance to the touch. I regard the "muscular sense" as a part of the sense of touch, for all that it cognises is also resolvable into pressure and resistance; it

Muscular sense.

appears uncertain whether there would be any sense of muscular motion whatever—that is to say, it is uncertain whether muscular action would give rise to sensation—if it were absolutely unresisted.[1] Our first cognitions of space, and of things existing in space, are due to the sense of touch, which so far is an intellectual sense; though in a developed state of the intellect we obtain information concerning external things chiefly through sight; but in blind persons the sense of touch, in virtue of its giving a cognition of space and of the form and position of things in space, is capable, in a great degree, of supplying the place of the sense of sight, in a way that no other sense could conceivably do. Sensations of touch do not admit of being reproduced in memory with any vividness.

Taste.

2. The nerves of taste are also nerves of touch and of heat, and when these sensations are experienced together, they are cognised as distinct. But when two tastes are mixed together, a single taste is cognised intermediate in character between its constituents. The sense of taste is not an intellectual one; it gives no cognition of space; and its impressions are scarcely at all capable of being reproduced in memory. Sensations of taste are due to the substances

[1] "Of the voluntary motion of our limbs we know originally nothing. We do not perceive the motion of our muscles by their own sensations, but attain a knowledge of them only when perceived by another sense. The muscles most under our control are those of the eye and the voice, which perform motions microscopically small: yet we have no consciousness of the motion. We move the diaphragm against the heavy pressure of the liver, &c., yet with as little consciousness of the motion. It follows that the motions of our limbs must be observed by sight or touch in order to learn that they move, and in what direction." (Weber, quoted in M'Cosh's Examination of Mill's Philosophy, p. 128.) Dr. M'Cosh quotes this in opposition to the theory of Mill and Bain, to be referred to in the next two chapters, that we acquire the cognition of space through the muscular sense alone.

which are tasted being dissolved in the moisture of the mouth.

3. The nerves of smell are not nerves of any other sense. Sensations of smell bear a greater resemblance to sensations of taste than do the sensations of any other two senses to each other: this is, no doubt, a consequence of the similarity in the physical conditions of their production; for sensations of smell are due to the vapours which are smelled being dissolved in the moisture of the nostrils. In other respects, also, the senses of taste and of smell resemble each other. Smell, like taste, is not an intellectual sense; it gives no cognition of space, and its impressions are scarcely at all capable of being reproduced in memory.

Smell. Its resemblance to taste.

4. The nerves of sight are not nerves of any other sense. All the sensations of sight may with perfect accuracy be called colours; for white may be regarded as a colour, black is the absence of any colour, and lustre is only a particular way in which light falls. According to the theory now generally received, and I think on demonstrative evidence, radiance consists of undulations in an ethereal medium. The undulations are of various lengths, but, so far as we are able to ascertain, they do not differ one from the other in any essential property, except that those rays whereof the undulations are between certain ascertained limits of length have the power of exciting the sensation of light; or rather (for the property is a purely physiological one), the nerves of the eye have the power of perceiving the sensation of light when they are acted on by those rays; and, what is most remarkable, rays which appear to differ only in the length of their undulations excite sensations of colour which differ not in intensity but in kind—such as red, green, and blue. This is an ultimate fact of sensation, and its reason is consequently quite inscrutable.[1] The subject of colours and their combinations being a very special one, I defer my further consideration of it to Note B at the end of this chapter.

Sight, or the sense of colour.

Only some luminous undulations produce the sense of light,

and these excite various sensations of colour.

The sense of sight gives a cognition of space, though I

[1] See Note A at end of chapter.

Sight gives cognition of space.

think it is demonstrable that the first cognition of space is obtained, not by sight, but by touch.

Characters of sight.

Sight is a highly intellectual sense; and in connexion with this is the fact, that impressions of sight are capable of being not only remembered, but reproduced in memory, or recollected, with great vividness.

Of hearing.

5. The nerves of hearing are not nerves of any other sense. Hearing, like sight, is a highly intellectual sense; and impressions of sound, such as those of voices or of music, are capable of being reproduced in memory with great vividness. Hearing gives no cognition of space in the sense of extension, but it does give a cognition of direction: all the higher animals, at least, appear to have some power of judging from what direction a sound comes. "It is commonly supposed that the 'semicircular canals' have for their peculiar function to receive the impressions by which we distinguish the direction of sounds; and it is certainly a powerful argument in support of this view that in almost every instance in which these parts exist at all, they hold the same relative positions as in man, their three planes being nearly at right angles to one another."[1] This power of judging of the direction of sound, however, is very deficient in precision; and without the assistance of other senses it would probably be quite insufficient to give rise to any cognition of space, at least unless it was incomparably more accurate than it is in man.

Semi-circular canals give a sense of the direction of sounds.

Hearing is unlike the other senses, in the power of discriminating simultaneous sounds.

That in which hearing differs from all the other senses is the fact, that distinct sounds falling on the ear together do not necessarily combine into a resultant sensation, as tastes, smells, and colours do when they are mixed. Unlike those other sensations, simultaneous sounds are capable of being recognised as distinct, and of being attended to separately. There is good reason to believe that this remarkable property of the sense of hearing depends on the peculiar manner in which the nerves of hearing terminate in the ear. The nerves of the other organs of sense branch out and form a network at their terminations: thus

Distribution of the

the nerves of touch, of taste, and of smell form extended

[1] Carpenter's Human Physiology, p. 669.

networks, the purpose of which appears to be to obtain the necessary extent of sensitive surface; and the optic nerve branches out into a network through the retina (which organ derives its name from this fact), for the purpose of providing a surface sensitive to light, on which the image of the object looked at is to be formed. But the nerves of hearing terminate in a totally different way from any of these.[1] No image has to be formed in the ear analogous to the retinal image in the eye, and consequently no sentient surface is needed like the retina, nor is an extended sentient surface needed for any other purpose. Consequently the nerves of hearing are not spread out at their terminations, but are concentrated together in "Corti's organ." There are about three thousand of these nerve-fibres; and we have good reason to believe that each one of these is sensitive, not to all sounds, but only to sounds of a pitch altogether or nearly identical with that to which it is itself strung. So that different sounds, when heard at the same time, are heard by different nerves, and make each its own impression on the consciousness: unlike colours, or smells, or tastes, which, when mixed, are felt by the same nerves, and make a combined impression on the consciousness.

Nerves of touch, taste, smell, and sight, to sensitive surfaces.

Distribution of the nerves of hearing different.

In order to explain how sounds act each on its own appropriate nerve, we must refer to the general laws of acoustic vibrations. Every stretched string has a period of vibration belonging to itself, which is not affected by the manner in which it is caused to vibrate, but is constant so long as its length and its tightness are unchanged; in other words, the number of vibrations which a string makes in a second is constant for the same string. The pitch of a sound depends on the number in a second of the sonorous vibrations, which, when transmitted through the air to the ear, excite the sensation of sound; so that the same string, by its vibrations, always produces sound of the same pitch —a single vibration of the string, of course, producing a single sonorous vibration, or sound-wave. The laws of

Laws of sonorous vibrations.

Period of vibration constant for the same string.

Pitch of note constant for the same string.

[1] For the following details, see the review of Tyndall's Lectures on Sound, in the Edinburgh Review of January 1868.

59863

vibration are the same in all bodies whatever; but vibrating strings exemplify those laws in their greatest simplicity and in the most manageable form, for which reason it is best, in treating of elementary acoustics, to speak of strings only. If two strings have the same period of vibration, and one of these is set vibrating, the sonorous vibrations produced by it will set the other string vibrating in unison: from the analogy of the case, and from the wonderful way in which the auditory nerve-fibres in "Corti's organ" are stretched like the strings of a violin across a bridge, we have every reason to believe that those nerves are such sympathetically vibrating strings. Every sound which enters the cavity of the ear sets in vibration that nerve which is strung to its own pitch, and its vibrations produce in the auditory ganglia the sensation of sound.

One string may set another vibrating.

Action of sound on the nerves of the ear.

It ought to be stated that this theory is not offered as a demonstrated truth, but only as having a very high degree of analogical probability. It is not easy to see any way in which it could be experimentally verified.

Tone of sound:

I have next to speak of the tone of sounds, which is a more complex fact than their pitch. The physical theory of tone may thus be stated in outline:—The tone of a sound is produced by the union of secondary sonorous waves, or *overtones*, with the primary sonorous wave, or *fundamental*. When the fundamental is not accompanied by any overtones, its sound is soft and dull, as that of a tuning-fork.[1] But such sounds are very unusual: there are overtones in nearly all sounds. Consequently, nearly all sounds are not simple but complex sounds. The overtones are of higher pitch than the fundamental. The pitch of the fundamental is what defines the pitch of the complex sound. A fundamental may be accompanied by many overtones. In a word, the tone of a sound is due to the combination of secondary sonorous vibrations with the fundamental. The secondary sonorous vibrations are of course due to the production of secondary vibrations in the musical string or other sonorous body.

how produced.

But now a question arises, How is any such thing pos-

[1] Tyndall's Lectures on Sound.

sible as a complex sound? Why do we not hear the overtones as distinct sounds from the fundamental, instead of hearing a complex sound unlike either? Why do sounds ever combine into a resultant sound, instead of being each transmitted along its own nerve-fibre separately to the auditory ganglia, so as to be distinct in the consciousness? I am inclined to think the answer is this: All sounds, when heard simultaneously, tend to combine into complex sounds, and the power of distinguishing them, like the rest of man's voluntary powers, has to be acquired by habit. In consequence of the laws which regulate the vibration of strings and other bodies, most sounds are accompanied by overtones; and as the fundamental and its overtones are habitually heard together, the ear in most persons never acquires the habit or the power of distinguishing them; while it easily acquires the power of distinguishing sounds which are heard together only by accident, such as two different voices. In distinguishing two voices which are heard at the same time, the ear is also, no doubt, very much guided by the fact that the different voices rise and fall separately, while a fundamental note and its overtones rise and fall together. But it is stated by Helmholtz[1] that it is possible to acquire by practice the power of distinguishing the overtones of a single vibrating string.

Why do the secondary vibrations, or overtones, combine with the fundamental into a resultant sound?

The combination or distinction may be due to habit.

With practice overtones may be distinguished.

The senses of sight and hearing are the only senses which minister to the intellect in any high state of intellectual development; and, no doubt for this reason, they are the only æsthetic senses—that is to say, the only senses through which we derive any ideas of beauty. It may be unusual to call that *beauty* which we admire and enjoy in music, but it certainly impresses the mind exactly as visual beauty does, making allowance only for the unlikeness of one sense to another. The objects of visual beauty are in general much more permanent than sounds can be, and they consequently give a more durable pleasure; but the pleasure due to music, on the other hand, is, while it lasts, more intense than that due to visual beauty. The reason

Sight and hearing are the most intellectual, and the only æsthetic senses.

Music produces a more intense

[1] Quoted in Tyndall's Lectures on Sound.

feeling than visual beauty, because the ear loses no time in combining impressions.

of this probably is, that the beauty, or what is called by an expression which is scarcely a metaphor, the harmony, of form and colour is due to the combination of several distinct impressions on the sense of sight, which cannot be properly combined without a motion of the eye; and this occupies some little time; while the harmony of sound is due to the combination of distinct impressions on the sense of hearing, which combine in the consciousness of themselves, without any time being lost. To this fact, that no time whatever is lost in combining simultaneous impressions of sound, while some little time is lost in combining simultaneous impressions of sight, I attribute the peculiarly vivid and intense effect of music on the consciousness.

NOTE A.

NERVES OF SPECIAL SENSATION.

Opinion of distinct nerves for distinct colours.

THE opinion was first advanced by Dr. Young, and has lately been sanctioned by the high authority of Helmholtz,[1] that there must be three distinct sets of nerve-fibres in the retina and the optic nerve, one for each of the three primary colours. On this subject it is difficult to see how there can ever be any absolutely conclusive evidence; for, supposing the three sets of nerves to exist, and to be distinctly visible under the microscope, how could the distinct function of each be ascertained? But there are what appear to me the strongest analogical reasons for rejecting such an hypothesis.

Reasons against this.

The hypothesis in question rests on the belief that each sensory nerve must transmit a single kind of sensation, and cannot transmit any other. Now this belief appears to be contrary to such evidence as we can obtain. Dr. Carpenter says of the sense of taste: "There is no special nerve of taste; for the gustative impressions upon the front of the tongue are conveyed (to the sensory ganglia) by the Lingual branch of the fifth pair, while those made upon the back of the organ are conveyed by the Glosso-pharyngeal, both of which nerves also minister to common sensibility (or the sense of touch); and pressure on the

No special nerves of taste,

[1] Physiological Theory of Music, French translation, p. 185.

trunk of either of these nerves gives rise to pain, which is not the case with either the olfactory, the optic, or the auditory nerves. Moreover, the papillary apparatus, through which the gustative impressions are made upon the extremities of these nerves, is essentially the same in structure with that of the skin."[1]

Moreover, if there is a distinct set of visual nerve-fibres for each primary colour, it would appear to follow that there must be a distinct set of nerve-fibres of taste for each distinct kind of taste—saline, bitter, sweet, &c.; and a distinct set of olfactory nerve-fibres for each distinct kind of smell; which would be an almost incredible conclusion. The case of the sense of hearing, as we have seen in the preceding chapter, is different from these.

Each distinct sound is probably transmitted to the auditory ganglia by a distinct set of nerves. But, as a result of this, it is possible to distinguish, as distinct, sounds which are received in the consciousness together; and if the impressions of different primary colours were transmitted to the optic ganglia by different nerve-fibres, we should be able to distinguish the constituent colours in a compound colour—we should be able to see the three primaries in white.

Nor of heat.

If it were true that any one nerve-fibre can transmit sensations of only one kind, it must follow that the nerves of the sensation of heat must be distinct from those of touch; but, according to Dr. Carpenter, there is no evidence whatever in favour of this conclusion.[2]

The kind of sensation depends not on the nerves nor on the ganglia, but on the organ of sense.

The truth appears to be, that the sensations which any nerve transmits depend neither on the constitution of the nerve itself, nor on that of its ganglion (for all nerves and all ganglia, so far as the microscope has shown, are histologically alike), but altogether on the constitution of the organ in which the nerve has its external termination. Thus a nerve which terminates in the eye transmits the sensation of light, and a nerve which terminates in the ear transmits the sensation of sound. The differences in kind between the sensations of different colours are no doubt left unexplained by this hypothesis, but they are inexplicable by any hypothesis whatever, and the difference between the tastes of sugar and of salt, or any other simple fact of sensation, is equally inexplicable.

The conclusion stated in the foregoing paragraph may appear

[1] Human Physiology, p. 617. [2] Ibid. p. 615.

to be contradicted by the well-known fact that pressure on the retina produces the sensation, not of pressure, but of light. But when the retina and the optic nerve have been habitually transmitting sensations of light ever since their first formation, it is I think what might have been expected that all their sensations, even when excited, not by radiance, but by pressure or by disease, should take the form of sensations of light.

Sensations of light due to pressure,

It is stated, that an electric shock sent in opposite directions along the optic nerve will produce, if in the one direction the sensation of red, and if in the other direction the sensation of blue.[1] This is a strong argument against the hypothesis of distinct nerves for each of the three primary colours; for it is difficult to believe that the set of nerves which produces the sensation of blue will produce their sensation in response to an electric current in one direction, that the set which produces the sensation of red will respond to a current in the opposite direction, and that the set which produces the sensation of green will respond to neither. It is far more likely that the opposite electric currents, or shocks, produce different sensations in the same nerves.

and to an electric current.

NOTE B.

COLOURS AND THE LAWS OF THEIR COMBINATION.

Difference between sensations of sight and of the other senses.

THERE are a great many distinct primary kinds of sensation of taste, of smell, and of sound. The same might appear to be true of the sensations of colour; but such is not the fact; all the sensations of colour which are possible, at least to the human eye, are capable of being produced by the combination of three primary elements.

Meaning of *light* and of *radiance*.

In what follows, I shall use the word *light* as only the name of a sensation. That which produces the sensation I shall call *radiance*. Radiance, however, has other properties than that of producing the sensation of light when it falls on the retina. It is a form of energy, and, like all forms of energy, it is capable of being transformed into heat: this takes place when sunbeams heat the body on which they fall. It has also many peculiar and little understood chemical effects; the whole art of photography is based on some of these.

Heating and chemical effects of radiance.

[1] I regret that I cannot find my authority for this statement.

There is what I regard as demonstrative evidence for believing that radiance consists of undulations in a universal ethereal medium. The radiance of the sun, and of all other sources with which we are familiar, consists of a variety of rays, which, so far as we know, differ from each other in no physical character except the length of the undulations of which they are composed. The velocity of all the rays is the same, and consequently the number of undulations, or waves, to the second in any ray is inversely proportional to the length of the waves that compose that ray. All the rays are capable of being refracted; the refrangibility is the greatest where the wave-length is the least; so that rays from the same source, as for instance the rays that constitute a sunbeam, may be separated by refraction through a prism; the rays of unequal refrangibility being refracted at unequal angles, and consequently proceeding in different directions. The unequally refracted rays, when received on a screen, constitute the prismatic spectrum.

Radiance consists of undulations.

Rays of different wave-lengths are mixed together in the sunbeam.

Their separation by the prism.

As radiance is a form of energy, and as all energy is capable of transformation into heat, it can scarcely be doubted that the heating-power of any ray is a measure of the quantity of energy due to it. When we apply this test, we find that the visible brightness of a ray has nothing to do with the quantity of energy which it contains; for the rays which have the greatest heating-power are scarcely if at all visible. This, of course, is not a physical but a physiological fact; or, in other words, it depends not on the nature of radiance, but on the constitution of our visual faculty. What is even more remarkable is that the greatest chemical, or actinic, or photographic power coincides neither with the greatest heating power nor with the brightest light; the rays of greatest chemical power, on the contrary, are almost if not quite invisible, and are at the opposite end of the spectrum from the heating rays.[1]

The places of brightest light, of greatest heating power, and of greatest chemical power, do not coincide.

The rays of different wave-lengths, and consequently of different refrangibilities, produce different sensations of colour in the eye. Beginning at the rays of the greatest wave-length and least refrangibility, and going on to those of opposite character, the succession is as follows:[2]—

Different rays have different colours.

[1] For the probable reason of the last mentioned fact, see a paper by Professor Tyndall in the Fortnightly Review for February 1869.

[2] I take this enumeration from Professor Grassmann's paper on the Theory of Compound Colours, in the Philosophical Magazine for April 1854.

Succession of colours.

Red, orange, yellow, yellowish green, green, bluish green, azure, indigo, violet, purple.

The rays of greatest heating-power are beyond the brightest red, and those of greatest chemical power nearly coincide with the purple. The colours graduate into each other, so that any accurate enumeration of tints is impossible. The fact that rays of different wave-lengths, which is altogether a *quantitative* difference, produce *qualitative* differences of colour, is a purely physiological fact, and one of which no explanation appears possible. It is, however, to be remarked, that the colour of light is not in any true sense analogous to the tone of sound.[1]

Difference of colour is a physiological fact,

and analogous not to tone but to pitch in sound.

The *pitch* of sound depends on the wave-length of the sonorous undulation, and its *tone* depends on the combination of secondary waves with the fundamental. In the manner of its production, the colour of light is analogous, not to the tone of sound, but to its pitch; for, as just stated, rays which have different wave-lengths, and have, so far as we know, no other difference whatever, excite totally different sensations of colour.

There is strong reason for believing that the colour of light corresponds to the pitch of sound in another and very remarkable way. It is a law of sound (or rather of the hearing faculty, for it is a physiological fact and not a physical one)—it is a law of the hearing faculty, I say, that any two notes whereof the sonorous waves producing the one are exactly twice as numerous in a second as those producing the other, are in a manner recognised as the same note, the one being the octave of the other. There is reason to think that the same is true of colours. What makes the subject obscure is the fact, which is a purely physiological one, that the power of perceiving sound extends over more than eleven octaves,[2] while the power of

The octave in sound and in colour

[1] It is, I think, to be regretted that the Germans, and Dr. Tyndall in imitation of them, have introduced the term *sound-colour* in the sense of tone. The word is not needed, for it expresses nothing that "tone" does not express quite as well, both in German and in English; and moreover, as shown in the text, the analogy it suggests is untrue.

[2] According to M. Despretz, "the number of vibrations required to produce an appreciable musical sound, in persons endowed with an acute sense of hearing, may vary from 16 [in a second] for the lowest, to 73,000 for the highest note." (Carpenter's Human Physiology, p. 660.) This is a range of rather more than eleven octaves; for the eleventh octave of a note of 16 sonorous vibrations to the second contains 65,536 to the second: that is to say, $16 \times 2^{1+11} = 65{,}536$.

perceiving light extends over but one.[1] The number of luminous undulations to the second of the faint purple-red rays beyond the violet is about twice that of the extreme red rays at the opposite extremity of the spectrum, and their wave-length consequently about one-half. Satisfactory observations on the subject are difficult, in consequence of the faintness of the purple rays, which makes them often difficult even to see, and still more difficult to identify with the red. Nevertheless, the transition from violet to red through purple is stated to be perfectly visible with good light and a good instrument; so that the colours of the spectrum really occur in the following recurrent order,[2] like that of the notes of music :—

Red, orange, yellow, yellowish green, green, bluish green, azure, indigo, violet, purple, *red again.*

If there is any doubt of the actual recurrence of the same tint of colour in the spectrum, though I believe there is none, this theory of an octave in the spectrum would still be in the highest degree probable; not only from the analogy of sound, but also from the visible fact that violet and purple are intermediate colours of tint between blue and red, just as orange is visibly intermediate between red and yellow.

It is obvious that this fact of an octave in the spectrum is an ultimate fact of sensation, not to be accounted for by any law of habit, or accounted for at all.

If the series of colours in the spectrum is recurrent, it is using only another word for the same fact to say that it is circular. A circular arrangement of the colours of the spectrum

The series of colours in the spectrum is circular,

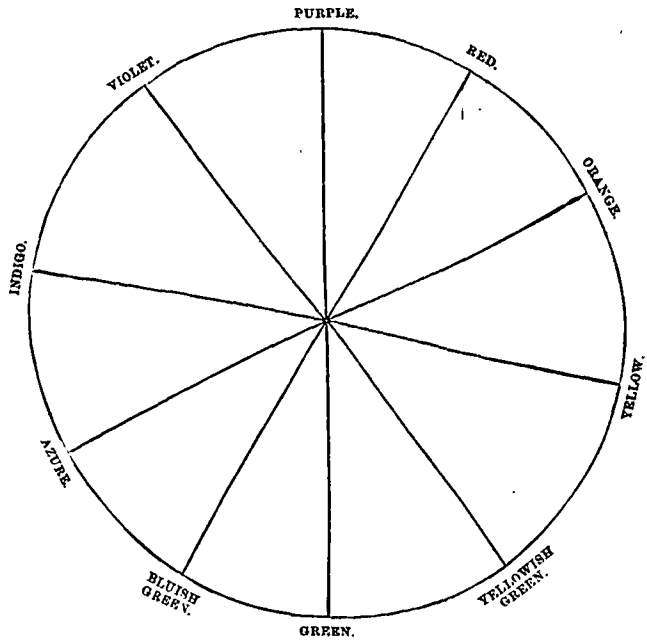
[1] According to Sir John Herschel (Good Words, August 1865), the luminous vibrations of the extreme red number 399,401,000,000,000 to the second, and those of the extreme violet 831,479,000,000,000; so that the latter are a little more than twice as numerous as the former, and the power of vision extends through a little more than an octave. No such determinations, however, can be anything more than approximative. The measurement of the lengths of the waves, and of their number to the second, is not subject to any great error, but it is a matter of great uncertainty where the extreme red and the extreme violet are; for the illuminated part of the spectrum graduates into darkness, and its extreme limits will be taken as at different points, according to the goodness of the light and of the instrument, and perhaps also according to the peculiarity of the observer's eyes.

[2] For the fact of this recurrence, see Professor Grassmann's paper already referred to.

is necessary, in order to give any right conception of the laws of the composition of colours.

and the opposite colours are complementaries.

It is possible to arrange the colours of the spectrum in such a circular order, that every opposite pair of colours in it shall be complementary to each other; that is to say, shall make white when combined. This order, according to Professor Grassmann, is that of the following diagram.[1]



[1] See the paper already referred to. Professor Grassmann does not give the circular form, but his tabular statement of the pairs of complementaries comes to the same thing. The law that every colour in the spectrum has its complementary in the spectrum was deduced by Professor Grassmann from theoretical considerations; and it has been to a great extent confirmed by the experiments of Helmholtz, who "found that the colours from red to green-yellow were complementary to colours ranging from green-blue to violet, and that the colours between green-yellow and green-blue have no homogeneous complementaries, but must be neutralized by mixtures of red and violet." (Professor Clark Maxwell on the Theory of Compound Colours, Philosophical Transactions for 1860.) I think there can be little doubt

So that any one of the following pairs of colours, when combined, will make white:—

Red and bluish green.
Orange and azure.
Yellow and indigo.
Yellowish green and violet.
Green and purple.

How to combine colours.

It is to be observed that, in such experiments as these, what we must do is to combine the colours themselves; and this is to be done by letting rays of the two colours which we wish to combine fall on the same spot of white paper. Mixture of colouring stuffs will not give the same results.[1]

Whites produced by the combination of different pairs of complementaries are optically different.

It is also to be observed, that the white produced by the combination of any one pair of complementaries, though the same in appearance as that produced by the combination of any other pair, is not really the same. The difference is shown by decomposing any white ray with the prism, which will separate it into its differently-coloured constituents; just as the common white light of day is decomposed by the prism into all the colours of the spectrum. Thus, the white which is compounded of red and bluish green may be separated by the prism back into red and bluish green; and the white which is compounded of yellow and indigo may be in like manner separated back into yellow and indigo. Thus, two whites may be, to use Professor Clark Maxwell's expression, *optically* different though *chromatically* alike. The white light of day is of course a mixture of the whites which are compounded of all the pairs of complementaries in the spectrum.

that the failure to find homogeneous complementaries (that is to say, complementaries in the spectrum) for the colours from green-yellow to green-blue is due merely to the faintness of the purple tints, among which by the theory their complementaries should be found.

[1] If we mix two or more colouring materials together, the colour of the mixture is due to those rays which are not absorbed by any of the materials; so that the more ingredients we put into our mixture the more rays are absorbed, and the nearer we come to the total suppression of light, which is blackness. Hence the necessity, in water-colour painting, of obtaining brilliancy, if possible, by a single wash of colour. If on the contrary we mix the colours themselves in the way described in the text, the more colours we add the more light we get. It is thus obvious that the two methods of mixing will not give the same results. For the remark about water-colours, see Sir John Herschel, in Good Words, August 1865.

All colours except white are in the spectrum. Black. Grey. Brown.

Except white, all possible colours are colours of the spectrum. Black is merely the negation of light, and grey is only a subdued or lowered white.[1] Brown tints, which to the eye appear unlike any of the colours of the spectrum, are "merely red, orange, or yellow, of feeble intensity, more or less diluted with white."[2]

Result of combining two colours not complementary, is to form compound colours visibly like simple ones, but optically different.

If two colours of the spectrum not complementary to each other are mixed in the way already described (the brightness of the two colours being of equal intensity), the colour produced by their combination will be similar in appearance to the colour situated half-way between the two constituents on the circumference of the circle of prismatic colours; and the compound will not necessarily be similar in appearance to either constituent. Thus, red and green form yellow. But such a compound colour, though it may be chromatically similar to a simple one, is of course optically different, and may be decomposed back into its constituents by the prism. The compound colours, however, though of the same tint with the simple ones, are in many cases less saturated, presenting the appearance of being diluted with white.

No distinction of primaries and secondaries in any physical sense,

It follows from this, that there is no distinction of primary and secondary colours,[3] for every colour may be either primary or secondary: primary, because it is found in the spectrum; and secondary, because it may be formed by the combination of other colours.

It also follows by mathematical consequence from the facts stated here, and has been verified by experiment, that if any three colours whatever are so taken from the circumference of the circle of prismatic colours, that the centre of the circle falls within the triangle whereof they are at the angles, either white

[1] Most of what are called grey tints, however, probably contain blue.

[2] Professor Clark Maxwell's paper, referred to in a former note.

[3] Sir David Brewster thought he had shown that the colours of the spectrum are not primary, but capable of further decomposition by passing them through coloured media. By this kind of decomposition he thought he proved that there are but three primary colours, namely red, yellow, and blue. Helmholtz however has, I think, shown satisfactorily that Brewster's results were due to an imperfect method of observing, and that no ray of the spectrum is capable of decomposition by passing through any coloured medium. A ray under such circumstances may be greatly weakened, but it preserves its tint unchanged. (See Helmholtz's paper in the Philosophical Magazine for December 1852.)

or any other colour may be formed by combining them in suitable proportions.[1]

We thus find that, as a *physical* fact, rays of all colours are equally primary. But Professor Clark Maxwell[2] has found reason, from observations on colour-blind persons, to think that, as a *physiological* fact, *sensations* of all colours are not equally primary; but that all other sensations of colour are compounded of the three primaries, red, green, and blue.

but there may be in a physiological sense.

I shall conclude this note with some remarks on the mathematical theory of chromatic octaves and complementaries. Logically they ought to have come earlier, but I think it better to leave the statement of the elementary laws of colour uncumbered by even the simplest mathematics.

Further mathematical considerations.

In what follows let us, as in musical science, speak not of the wave-lengths, but of the frequency of the waves; that is to say, the number of waves in a given time. The frequency is of course inversely as the length.

Wave frequency.

Having ascertained the wave-frequency to which either a sound or a colour is due, we find the wave-frequency of its octave by multiplying by two, or of its lower octave by dividing by the same. Extreme purple is the octave of extreme red, and on the chromatic circle drawn above these are separated by an arc of 360°. Now, the pairs of complementaries, as I have laid them down, are separated, each colour from its complementary, by an arc of 180°. If this circular arrangement of colours represents any truth of nature, it might consequently be supposed that, having ascertained the wave-frequency of any colour, we should be able to find that of its complementary by multiplying or dividing, as the case may be, by the square root of two. That is to say, if we arrange the colours, from red to its octave where purple turns red again, round the 360 degrees of a circle, in such a way that any two colours separated by equal arcs shall have their wave-frequencies in equal ratios; then, as the wave-frequencies of the two reds which are

A colour and its octave are 360° apart on the circle.

[1] See Professor Clark Maxwell's paper, already referred to.

[2] See the same paper. According to Professor Clark Maxwell, most colour-blind persons (so called) are insensible to any difference between red, yellow, and green, but sensible to the difference between these and blue or violet. But there is another less common kind of colour-blindness, which consists in insensibility to the difference between green and blue.

We might expect complementaries to be 180° apart.

separated by an arc of 360° stand to each other in the ratio of 1 to 2, the wave-frequencies of any pair of colours which are opposite to each other in the circle must be in ratio of 1 to the square root of 2. It might, I say, be expected, that such pairs of opposites should be pairs of complementaries.

But this does not appear to be the case. According to Professor Clark Maxwell, the wave-frequencies of some of the pairs of complementary colours are in the ratios of the numbers here given with them;[1] each colour being the complementary of that opposite to it in the other column.

Red . . .	36·40	Bluish green .	47·65
Orange. . .	39·80	Blue . . .	51·80
Yellow. . .	41·40	Indigo. . .	54·70

If the wave-frequencies of the colours in the right-hand column were to those of their complementaries in the ratio of the square root of 2 to 1, they would be—

Bluish green	51·47
Blue	56·28
Indigo	58·54

Discrepancy of observation and theory.

It will be noticed that the observed wave-frequencies of these three colours are considerably smaller than those calculated by the hypothesis from the wave-frequencies of their complementaries; and the differences, besides being all on the same side, are too great to be accounted for by any accident or error. Thus in such a circle as I have imagined (in which equal distances along the circumference correspond to equal ratios of frequency), any two complementaries are not precisely opposite, but approach each other on the green side of the circle.

How accounted for.

From a mathematico-physical point of view this may appear anomalous, but it is easily explained from a physiological one. White is not a mathematical expression; it is the name we give to the colour-sensation produced by sunshine. We say that the rays of which the sunbeam is composed are of very unequal

[1] See the paper already referred to. The determinations were made by means of an interference-spectrum, obtained by an application of the principle of Newton's rings, and the numbers given are the numbers of wave-lengths in the retardations. The determinations are for the positions of certain of Fraunhofer's lines. In the cases of bluish-green, blue, and indigo, I have taken the mean of the determinations for two or three lines in the same colour.

brightness; that its green, for instance, is much brighter than its purple. But this is not strictly accurate; it is our faculty of vision which is so constituted as to be more forcibly impressed by the green rays than by the purple ones. This is a purely physiological fact, and it is quite possible that there may be animals which have eyes that are more forcibly impressed by the purple than by the green.[1] If all parts of the spectrum were of equal brightness to our eyes, then equal arcs of the circle would contain equal quantities of colour, and equal and opposite arcs would neutralize each other, forming white. The circle, as we have seen, is divisible into arcs of the following pairs of complementary colours:—

All the rays are not equally bright to our eyes.

Red and bluish green	=	White.
Orange and azure	=	White.
Yellow and indigo	=	White.
Yellowish green and violet	=	White.
Green and purple	=	White.

Were a pair of complementaries always of equal brightness, it is obvious that, in order to make white without leaving any residual colour, they ought to occupy equal arcs of the circle. But this is not the case; the colours on the green side of the circle are much brighter than those on the purple side; so that the combination of equal arcs (or, in other words, of equal quantities) of the two would not produce pure white, but would have a residual green tinge. The neutralization, or conversion into white, of all the colours, without residual tinge from any of them, is attained by the brightest colour of any pair of complementaries occupying the smallest arc; and, as the colours are brighter on the green side of the circle than on the purple side, this involves as a geometrical consequence that the colours which we might have expected to find separated by an arc of 180°, are a little nearer to each other by the green side of the circle.

As stated above (see p. 112), all possible colours are contained in the spectrum, except white, black, and grey; though many tints, especially the various tints of brown, are so inferior to

[1] It has been suggested that cats and owls, and other animals which see well in twilight, may have eyes unusually sensitive to the very refrangible rays,—the violet and purple, and the photographic rays invisible to us,—which are relatively more abundant in twilight than the less refrangible ones.

those of the spectrum in intensity and in degree of saturation that the eye does not identify them.

There are three, and only three, ways in which any two tints of colour can possibly differ from each other. These are:

1. In the order of the colour: or, in other words, the position of the colour in the chromatic circle.

2. In the intensity of the colour. And

3. In the intensity of the white with which the colours of all substances are diluted.

Possibility of giving a formula for any tint.

Professor Clark Maxwell has made the important remark, that, as these three elements all admit of numerical statement, it is possible to give an arithmetical formula for any possible tint. The intensity, or brightness, of the colour itself and of the intermixed white may of course be numerically valued, taking as unity for each colour the brightest tint that can be obtained by means of pigments. The order of the colour may be stated in degrees of the chromatic circle, which for such a purpose ought probably to be so arranged that each colour should be exactly 180° from its complementary.

Scientific principles of harmonious colouring.

I am convinced that the principles of harmonious colouring are to be found in the laws of the combination of colours stated in this note. I do not know how far Mr. Ruskin is right in saying that no rules for harmonious colouring are worth anything, but if he is right that no such rules of any value have been yet laid down, it does not follow that he is right in maintaining it to be in the nature of things impossible for such rules ever to be discovered. If we have no rules of any value for harmonious colouring, this is only because the true laws of the combination of colours have not been long known. We know what science has done for the kindred art of music, and with this analogy it is to me incredible that science should be unable to discover valid and valuable rules for the art of colouring.

CHAPTER XXXVI.

PERCEPTION.

IT is an axiom concerning which there is no dispute, that mind begins with sensation. It is also agreed by all, that sensation is inexplicable. But the most debated question of psychology is, how sensations give rise to perceptions. The problem, how sensations give rise to perceptions.

When I speak of perception, I mean more than the mere cognition of a sensation. Any sensation whatever may be the object of cognition; any sensation becomes the object of cognition in the act of directing attention to it. But a sensation may be cognised without its giving rise to any perception. Nothing, for instance, is perceived in cognising the general sensation of being well or ill, vigorous or weary. That which we *perceive*, according to what I regard as the accurate use of the word, is not the sensation itself, but that to which we refer the sensation. And I propose to define perception, as *that act by which the mind refers sensations to their sources.* I must, however, in some degree qualify this definition. The perceived source of a sensation—that is to say, the source to which in the act of perception we assign the sensation—may be remote in space: thus, if I receive a ray of light from a star on my eyes, and thereby perceive the star, that which I perceive is at an almost immeasurable distance. But the perceived source of a sensation cannot be remote in time; it must be present in time; if the source to which the mind refers the sensation belongs to past time, the act of referring the sensation to its source is not called perception, but inference. Thus, if I cognise the sensation of thirst, I may perceive that my throat is dry, and may infer that this is

Perception is more than cognition: it is the referring of sensations to their sources,

caused by my having eaten salt meat an hour ago. We must consequently modify the definition of perception offered above, and call it *that act by which the mind refers sensations to sources present in time.* This is the most accurate definition I can offer, but it is not perfectly accurate; it includes as perceptions some acts which are really inferences. Thus, I may cognise a local pain arising from disease, and I may know with perfect certainty the state of the diseased part which causes the pain; yet the knowledge by which I assign the painful sensation to its source may be a case, not of perception, but of very circuitous inference.

the sources being present in time.

I believe, however, that it is in the nature of things impossible to frame a definition which shall be such as to include all that are really acts of perception, and to exclude all that are really acts of inference. And the reason of this, in my opinion, is that perception and inference graduate into each other. Perception indeed is an inference; it is only the first and simplest case of inference. When we refer a sensation to its source —as, for instance, when we refer light to a star, and in so doing perceive the star—I do not regard the perception as a simple inexplicable act of the mind; I regard it as an inference, instantaneously and spontaneously made. This view is supported by the fact that the same act may appear to be a perception or an inference, according as it is performed at once and spontaneously, or with hesitation and with some effort of thought. Thus, dogs perceive by the smell. A dog will smell a dead animal and perceive at once where it is; when a man may ascertain its presence only by considering for some little time what the source of the unpleasant smell can be, and even then may remain in some degree of doubt. It is, I think, quite impossible to point out any difference between the dog's unhesitating perception and the man's hesitating inference, except the mere circumstance that the one is instantaneous, while the other occupies an appreciable time. It may be said that perception is an unconscious process, while inference is a

A perfectly accurate definition is impossible.

Perception is an inference.

The same act may be the one or the other, according to circumstances.

conscious one. This is true—at least it is true in the case just supposed; but the unconsciousness of a mental process is a result of its being habitually performed. We can perceive by sound, as accurately as the dog can perceive by smell, and we can perceive the presence of our friends by their voices; but this is altogether an acquired perception, depending on habitual association: when we are learning to know a man by his voice, the power of identifying him graduates from hesitating inference to unhesitating perception; and when it has become perception, it is accompanied by no more conscious thought than the spontaneous perceptions of an animal. And when inferences—that is, what are indisputably inferences—are performed at once, spontaneously, and without effort, we habitually speak of them as perceptions. David *perceived* that his child was dead, when he saw the servants whisper.

The subject has been complicated by extraneous questions.

I believe this account of perception in itself presents no difficulties. I believe the difficulties with which the question is generally surrounded do not arise from any metaphysical perplexity in the nature of the subject itself, but from its being complicated with other questions which come before us in connexion with it. These questions concern the relation of the mind to space, and the relation of the two senses of sight and touch to each other in the act of perception; so that in the treatment of the theory of perception various questions have got mixed up together, concerning the nature of that act by which the mind refers sensations to their sources, the nature and origin of the cognition of space, and the mode in which the sensations of sight and touch are combined in the perception of bodies. To these three distinct inquiries some writers add a fourth, namely, the nature of the idea of material substances as distinguished from their properties. It is no wonder if four such questions appear inextricably perplexed when they are all mixed up together, and yet may prove to be manageable enough if they are taken separately.

I have stated my belief that perception is to be defined

Perception, and the cognition of space, are distinct, but have been confounded.

as an instantaneous inference. The next question to consider is the nature and origin of our cognition of space. These two questions—how we perceive, and how we become cognizant of space—are nearly always confounded; and this confusion has its expression in the use of the term "the external world," as synonymous with "the world existing in space." The two may be identical in fact, but they are not necessarily identical in thought. We may conceive a being with consciousness and thought like our own, but with no sense except that of hearing. Such a being could not possibly acquire any idea of space, yet it might perceive—that is to say, might infer—the existence of a world external to itself. On the other hand, I believe it is possible to be cognizant of space, and of relations in space, without perceiving an external world as existing in space; and not only so, but I believe we necessarily cognise the existence of sensations as related in space, before we perceive the objects to which we refer the sensations: in other words, that we must have cognised space before we can begin to perceive objects as existing in space.

We cognise space before we perceive objects in it.

I go on to state more fully the way in which, as I believe, we cognise space. When I speak of two or more sensations, I must be understood as meaning sensations of the same sense. Let us imagine what may take place when consciousness is being first awakened by sensation. A ray of heat falls on a spot of skin; this is cognised as simply a sensation, and nothing more. A second ray of equal intensity falls on the same spot of skin; this is not cognised as a distinct sensation, only the first sensation is now cognised as having increased in intensity. But let the second ray fall on a different spot of skin; this will be cognised as a distinct sensation, in all respects similar to the first, but separated from it in space. This, I believe, is the elementary form of the cognition of space. It is, in my opinion, a case of pure primary cognition, without any element of inference; just like the cognition of unlikeness that would be produced if the two sensations were different. Or, instead of supposing a second sensation at some distance from the first, let us suppose that the warm spot is moved

Cognition of two sensations as separated in space.

over the skin; this will be cognised as a change, not in the character of the sensation, but in its locality; and this also will give rise to a cognition of space. I do not say that such experiences as these will give a fully developed cognition of space. They can only give the cognition of space of two dimensions; of surface only, not of solidity. But I believe they can, and do, give the first rudimentary cognition of space.

Cognition of space by the motion of a sensation.

In these ways, only superficial extension can be cognised.

I do not suppose that the cognition of space could be produced by a uniform sensation spread over a sensitive surface, such as the sensation of heat over the whole skin of the body when in a warm bath: just as the cognition of time could not be produced by the unchanging continuance of the same sensation. The cognition of time is produced by the commencement, the cessation, or the change of sensations; and the cognition of space, as I believe, is produced in an exactly parallel way, by the existence of sensations at the same time in different parts of a sensitive surface.

Cognitions of space and of time originate in parallel ways.

By these merely passive sensations, we acquire the cognition of space-relation between our own sensations only; and that, I think, in space of only two dimensions. The cognition of a third dimension in space is, I think, due not to any merely passive sensation, but to our motor activity, and the sensation of it; and to the same "muscular sense" is due the perception of objects in external space—external, that is, to the body. Our perceptions of external objects, in so far as they are derived from touch and not from sight, consist of combined impressions of form and resistance (this analysis is admitted by all writers on the subject); and I believe that these perceptions are inferences from our sensations of motion and of resistance to motion. This will be intelligible to any one who will watch, or imagine, a blind man examining a new object with his hands. He moves them round it in order to ascertain its form, and feels its resisting power in order to ascertain its hardness or softness.

Perception of objects external to the body is acquired by the motor sense.

There are thus three possible ways in which impressions on the senses may produce a cognition of space; and I

Summary.

have no doubt the three actually co-operate in producing it. These are—

1. The existence of two or more sensations in different places at the same time.

2. A sensation changing its place.

3. Our own motions.

Sight, like touch, originally cognises only superficial extension.

We cognise space, or extension, by the sense of sight as well as by that of touch; and in sight, as in touch, we are originally cognizant of superficial extension only. What we originally see is only coloured surface; and what we are originally cognizant of in seeing is only sensations of colour, and the mutual relations of those sensations in superficial space. The power of perceiving—that is to say, of inferring—the existence of external objects by sight, as by touch, is a later acquired power.

Perception by sight is an acquired power.

Facts confirming these views.

This view, that the cognition of space is at first of superficial space, is, of course, not capable of proof. But it is very strongly supported by a fact of which every one's consciousness will inform him; namely, that it is easier to think of extension as superficial than either as linear or as solid. If we desire to think of a line, we imagine a surface and draw the line on it. If we desire to think of space of three dimensions, we imagine a surface, and then, I think with some little difficulty, add the third dimension. Such a fact as this may be compared to those facts of organization which have no bearing on the functions of the adult, but are records of the process of its development. It may be said that on my theory of the acquisition of the cognition of space by the co-existence of similar sensations in different parts of the sentient surface of the body, there is no reason why our first thoughts of extension should be superficial rather than linear. I reply, that in practice we become cognizant of extension, not by the co-existence of two separated sensations, but by the co-existence of an indefinite number of sensations, some of them similar and some unlike, spread over the surface of the body; and thus our first perceptions of extension are not linear, but superficial.

Answer to objection.

I have as yet spoken only of perceptions by a single

sensation. But in the most important class of perceptions —that is to say, in those of sight—elements from the two senses of sight and touch are combined. The peculiarly intimate connexion between those two senses is due to the fact, that they alone of all the senses give any cognition of space.[1] Space has become more associated in our habitual thoughts with sight than with touch; but the origin of our cognition of space in its three dimensions must be due, not to sight, but to touch (including the muscular sense as belonging to the latter); for the hand, which is the principal organ of touch, is capable of moving in all three dimensions, and thus of giving origin to the cognition of three dimensions; while the eye, whether at rest or in motion, has no way of cognising a dimension. It is true that the eye acquires a power of estimating distance, not only by the effects of perspective, but by means of the varying optical adjustments which are spontaneously made for varying distances; but this power is later acquired, and is far inferior in accuracy, as well as totally different in kind, from the power of the eyes to appreciate the space-relations of surface. It has been shown by observations made on persons born blind who afterwards received sight by the removal of the congenital cataract, that they knew simple superficial forms, such as a circle or a square, when presented to their sight, but had no perception whatever of the distances of objects from the eye.[2]

Perceptions due to both touch and sight. Special connexion of these two senses.

Cognition of space in three dimensions is due to touch.

[1] See the chapter on the Physiology of the Senses, in Dr. M'Cosh's Examination of Mill's Philosophy.

[2] See Dr. M'Cosh's chapter, already referred to. Berkeley said that a person born blind, and acquiring sight suddenly, would not know a circle from a square. In his time, no observations on the subject had been made. It has been subsequently stated, that his purely theoretical views have been confirmed by observations on persons cured of congenital cataract; but a very carefully observed case reported by Dr. Franz of Leipzig (quoted by Dr. M'Cosh from the Philosophical Transactions of 1841) appears conclusive as to the cognition of superficial extension. With respect to the inability of the eye to perceive the distance of objects from itself, until it has learned to do so by practice, Mr. Abbot, in his work "Sight and Touch," argues that no observation of the kind is in the least degree conclusive; because in all such cases as yet recorded there has been but one eye, so that the patient has been without those means of perceiving distance which are given by the simultaneous use of two eyes; and in that

Additional proof of this.

Our habitual mode of thinking of space is such as to afford additional proof that we have our first cognition of space from touch rather than from sight. The magnitudes which the hand cognises and measures are linear magnitudes: the magnitudes which the eye cognises and measures are angular magnitudes. If our conception of space is derived from touch, we ought to think of linear magnitudes more easily than of angular ones. If, on the contrary, our conception of space is derived from sight, we ought to think of angular magnitudes more easily than of linear ones. Now, the former of these two is the case with us; we think more easily of linear than of angular magnitudes. This is the more remarkable, because, once angular magnitudes are understood, they are as easy to reason about as linear ones, and much easier to measure: but no one clearly conceives what angular magnitudes are until he has received his first lesson in mathematics; and words denoting linear magnitudes and directions are abundant in colloquial language, while words denoting angular magnitudes and positions are all in some degree technical. Such words as above, below, before, behind, right, left, mile, and inch, belong to common language; while such words as altitude, azimuth, and degree, belong to scientific language. To speak technically, our spontaneous thoughts of space, whether superficial or solid, are always in terms of rectilinear co-ordinates, never in terms of polar co-ordinates.

Touch cognises linear magnitudes; sight cognises angular ones; and we think more easily of the former than of the latter.

Words denoting the former are common: words denoting the latter are technical.

A being with sight only would cognise only angular magnitude.

Were a being with mental faculties like ours to have no power of moving about, and no sense except sight, it could, and would, form an idea of angular magnitude, but not of linear magnitude. It would see all things, as we see the stars, on the surface of a hollow sphere, of which the

one eye the optical apparatus for adjusting the lenses of the eye to varying distances has inevitably been destroyed in the operation for cataract; so that, by the mere physical conditions of the case, there could be no power of perceiving distance by the eye, until the effects of perspective were learned. This is perfectly true as to the fact. My conviction that the cognition of space is originally derived from touch, and not from sight, is not grounded on any such observations, but chiefly on the reasoning in the next two paragraphs, which, so far as I know, is original.

centre would be its own eye; but it would be totally unconscious of any distance between its eye and the objects. Not, however, that they would seem close to its eye; the question whether they were near or far would for it have no meaning.[1] If in the course of its development it were to acquire a hand or a tentacle, by means of the motions of that organ it would acquire the sense of distance, and then its knowledge of the properties of space would be as complete as ours; but, as its ideas of angular magnitude were more early acquired than its ideas of distance or linear magnitude, it would always think more easily of the former; and it would spontaneously think of space in terms of polar co-ordinates. But if, on the contrary, the organ of touch were developed first and the eye afterwards, it would acquire its ideas of distance or linear magnitude first, and of angular magnitude later; and it would consequently always think of space in terms of rectilinear co-ordinates. Now this last is practically our case.

Impressions of the two senses are identified in the mind,

In all perceptions and ideas of bodies as existing in space, impressions of sight are combined and practically identified with impressions of touch. Thus, if I perceive the size of a book by the eye, I know of what size it will seem to the hand; or if I first perceive its size by the hand, I know of what size it will seem to the eye. In common language it would be said that it seems of the same size to both. But how can it be possible to identify an angular magnitude and a linear one with each other? The identification is the result solely of habitual experience. If we had no means of ever touching what we saw, and no means of ever seeing what we touched, we should have no notion of identifying the two, nor would it be possible for us to do so, even in imagination; for there is no common measure for linear and angular magnitudes; nor is there any resemblance between the sensations of light and colour felt by the eye, and the impressions of contact and resistance felt by the touch. Without experience there would be no more connexion in perception or thought between the objects of sight and of touch, than there is between colours

as the result of habit.

[1] See Note at end of chapter.

and sounds. But experience has taught us that, as a general rule, wherever there is a sensation of sight there is a possible sensation of touch; and wherever there is a sensation of touch there is a possible sensation of sight. That is to say, if I raise my eyes and see, for instance, my paper-cutter, I know that on stretching forth my hand I am certain to meet with a corresponding sensation of touch; or if I stretch forth my hand and feel it, I know that on raising my eyes I am certain to meet with a corresponding sensation of sight. The two sensations are met with together; and this is our only, but quite sufficient, reason for referring them to the same object.[1]

Account of the process.

This truth, that the identification of visual and tangible objects is solely due to experience, was first seen by Berkeley, and is the essential point of his celebrated theory of vision. He deduced it from purely theoretical data, and it has been subsequently confirmed by observations on persons cured of congenital blindness by the removal of a cataract. It is found that persons under such circumstances have to learn to see, just as children have to learn to walk; or, to quote Dr. M'Cosh's expression, they "require observation and thought to reconcile the information they had got from touch, with that which they are now receiving from sight; just as persons who have learned two languages, say German and French, require practice to enable them readily to translate the one into the other."[2]

Berkeley.

Quotation from M'Cosh.

[1] A very remarkable instance of the facility with which what may be called habits of perception are formed is afforded by the fact that persons the axes of whose eyes are far from parallel—that is to say, persons who squint—have the visual images necessarily formed on parts of the two retinas which do not correspond, and yet they *see single*. When the two axes have been set parallel by an operation, so that the two images come to be formed on corresponding parts of the retinas, the patient *sees double* at first, but soon learns to see single. (Carpenter's Human Physiology, p. 705.) In this case, however, there must be some organic change in the nervous connexion between the two eyes and the optic ganglia.

[2] See the chapter referred to in a former note. It may not be a familiar fact that translation is an art which has to be learned by practice, even when familiarity with two languages exists already;—in other words, that facility in translating with accuracy from one language into another is not a matter of course, even to those who know both languages well;—but it is true.

Berkeley, however, left unsolved, and I believe unattempted, the real difficulty of his theory. I mean that concerning the instinctive motor actions of animals. Young ducks, for instance, run to the water and begin to swim as soon as they leave the egg; so that we see them able to perform, without having learned, actions of the same character as those which a child performs in consequence of having learned, such as walking or feeding itself. Now, the actions of young ducks, and of most young animals, evidently involve perception, and are a result of it. What then becomes of Berkeley's theory, that the perception of objects has to be learned? To state the argument more clearly:—The young duck knows—not consciously, but in an unconscious way that serves it for guidance—that the water which it sees is water in which it can swim. It leaves the egg, not only with the same power of sensation which man possesses at birth, but also with that power of perception which, if Berkeley's analysis of perception is correct, man only acquires gradually and by experience. It is no explanation to say that animals are instinctive, but man is rational. We have no ground for thinking that there is any fundamental difference between instinct and reason; or, since the words instinct and reason have acquired misleading associations, I will say rather between the animal powers of mind and the lower human ones.

Difficulty about instinctive actions, as a duck running to the water when it leaves the egg.

In this state the question was left by Berkeley; and Mill, in a review on the subject, which was first published more than twenty years ago, after stating with his usual ability the grounds for believing that we have no possible means, except experience, for identifying the objects of sight with the objects of touch, concluded by admitting the instinctive actions of animals as an unsolved difficulty in the way of Berkeley's theory. When my attention was first directed to the subject, this difficulty appeared to me not a merely residual difficulty, like those planetary perturbations which the theory of gravitation failed to account for in Newton's time; it appeared to amount to a refutation of the entire theory. But recent speculations on the nature of instinct and of mind, especially the speculations

of H. Spencer, have shown that Berkeley's theory is really consistent with all the facts, and that the difficulty is only apparent. The question is, how is the duck able to recognise water without having seen water, and to swim without having learned to swim? And the answer is, that these are habits which have become hereditary and consequently instinctive. The race has learned them, and they are consequently instinctive in the individual. The individual has learned them, not in itself but in its ancestors. But the power of perceiving by means of sight, which power is obviously implied in the duck running to the water when it sees it, is, in the duck as well as in man, purely the result of experience; only that in man it is the experience of the individual, in the duck it is that of the race.

Explanation: these are cases of hereditary habit.

I do not deny that the explanation is in some degree hypothetical, for there is no possible test for deciding what are the results of habit, and what of unconscious organic intelligence, acting independently, or as it were in anticipation of habit. But the explanation I have offered, in which, I believe, every authority would now agree, has the only proof of which the nature of the case admits: that is to say, the cause alleged is known to exist, and is adequate to produce the effect.

As I have stated at the beginning of this chapter, I believe that perception is neither a simple act nor an inexplicable one, but merely the simplest of all cases of inference. The fact that we perceive not by one but by several distinct senses is enough to raise a very strong presumption that perception is not a simple inexplicable act, but one that admits of analysis and explanation. And what raises the probability, I think, to a certainty, is the familiar fact that in many cases we are at a loss whether we ought to refer the sensation to anything external, or to account for it by the disordered state of the organic system. The multiplicity of the senses is, however, a cause of difficulty in the understanding of the subject; and it is still further complicated by the combination, in the most important class of perceptions, of impressions derived from the two senses of touch and sight. It is

Presumption that perception is not a simple act, from the multiplicity of senses.

Difficulty of the subject, from their multiplicity, and their combination.

quite conceivable that in a different world from this, a mental nature as highly developed as ours might be evolved out of the germ of a single sense, at least if that sense were sight; and to such a being the nature of perception would probably present no difficulty whatever.

Elements involved in perception enumerated.

I think I have shown in this chapter that what we call perception, and naturally regard as a single mental act, really consists of distinct elements, which may be thus enumerated:—

Assignment of a sensation to its source.

1. The referring of a sensation to its source; as when we recognise a voice as that of a friend, or, in other words, perceive the friend by means of his voice. This has not necessarily anything to do with the cognition of space. It is true we know that every sound must come from some place, but it is not by means of the sense of hearing that we have learned this. Had we no sense except hearing, we should have no cognition of space at all.

Cognition of space-relations.

2. The cognition of space-relations between our sensations; and

3. The cognition of a third dimension in space by means of the motor or muscular sense.

Perception of objects in space.

4. Having learned to refer a sensation to a source, and having acquired the cognition of space in three dimensions, we become able to perceive the source of a sensation in external space; that is to say, to perceive objects external to the body.

Combination of impressions of touch and sight.

5. Lastly, we learn to combine the impressions of sight with those of touch, and thus to acquire the very complex ideas that we have of external objects.

I believe that by thus separating the complex subject of perception into its elements, we remove the difficulties which have hung round it, and make it as explicable as any mental function can be.

What is "the external world" external to

One cause of difficulty concerning the present subject is the ambiguity of the expression "the external world." What is this understood to be external to? Is it to the mind, or only to the body? In other words, is the body part of the external world? This question may appear to be only a verbal one; and we may appear to dispose of it

It may be extra-mental, or only extra-organic.

by speaking, instead, of the extra-mental world, which includes the body, and of the extra-organic world, which does not include the body.[1] But I think the question represents a real though a soluble difficulty. If I am right in agreeing with those who think that perception is an inference, we may define the internal world as consisting of all that is known by direct consciousness; and the external world, as including all that is known only by inference therefrom. In so far as the body is the seat of sensations, it is part of the internal world: in so far as it is an object of perception, it is a part of the external world.

No organ of sense can perceive itself.

It is here to be observed, that when one of our organs of sense becomes an object of perception, it is perceived, not by itself, but by another organ of sense.[2] Sight and touch are the only organs by which we perceive objects, because they are the only organs of sense that give any idea of space. The eye cannot see itself, but the hand can feel it; one hand, or at least one finger, cannot feel itself, but the other hand can feel it, and the eye can see both the hands. Had we but one sense, and were the organ of that one sense incapable of becoming an object of perception to itself, and consequently incapable of becoming an object of perception at all, it would not occur to us to regard it as a part of the external world.

[1] "I have endeavoured to show that the difficulties connected with the apparent deception of the senses can be removed by attending to three distinctions:—1. That between our original and acquired perceptions: 2. That between sensation and perception: 3. That between the objects intuitively perceived: all of them being *extra-mental*, but some of them also *extra-organic*." (M'Cosh's Examination of Mill's Philosophy, p. 171, note.) "Objects intuitively perceived which are not extra-organic," must, I suppose, be states of the organism, such as dryness of the throat.

[2] This remark has been made by Professor Ferrier.

NOTE.

As stated in the foregoing chapter, an intelligent being, which should derive its knowledge of space from sight alone, could have no idea of more than two dimensions in space. The eye sees surface only; and if knowledge of space came exclusively through the eye, it would be of superficial extension alone. And further: the superficial extension thus cognised would not be that of a plane surface, but that of the interior surface of a sphere; for, as previously stated, the eye really sees all things, as it sees the stars, projected on the interior surface of a sphere. It would consequently be impossible for such a being to have any knowledge of the properties of a plane surface, or of any surface except a spherical one; and as a straight line cannot be drawn on a sphere, it could have no idea of a straight line. All plane surfaces would appear to it as portions of the surface of the sphere, and all straight lines would appear as arcs of great circles drawn on the sphere. The propositions of solid geometry would be unmeaning to such a being; the propositions of plane geometry would appear to be true only on an infinitely small scale; and a race of such beings would perhaps make the first great improvement in their methods of studying geometry, by introducing the conception of infinitely small portions of surface, in order thereon to study the properties of lines and figures.

Case of a being having knowledge of space from sight only.

It would cognise only surface, and that the surface of a sphere.

It would see straight lines as arcs of great circles.

Plane geometry would seem true to it only on infinitely small surfaces.

There is nothing hypothetical in all this; it is simple mathematical truth. It is mathematically impossible for the eye to see a plane surface or a straight line. Plane surfaces, and indeed all surfaces whatever, are *seen* as portions of the surface of a sphere: straight lines are *seen* as arcs of great circles on the sphere. Every one who understands enough of geometry to perceive the absurdity of asking whether the moon appears bigger or less than a cheese, is aware that this is true of the heavens; and every one who has studied the theory of perspective knows that it is true of what we see on the earth. When we *perceive* plane surfaces and straight lines by sight, we do not *see* them; we *infer* them from what we see. Perception is only

The eye cannot see a plane surface or a straight line.

Straight lines are seen as arcs of great circles,

a rapid inference. The *conception* of plane surfaces and straight lines, or rather the possibility of those conceptions, comes not through sight, but through touch.

Parallel straight lines never meet; but two parallel great circles cannot be drawn on the sphere. Any two great circles must necessarily intersect each other in two points (thus the meridian lines on a globe intersect at the two poles). Now, as straight lines are represented to the eye by arcs of great circles, it follows that straight lines *as seen by the eye* are lines which would meet and intersect if they were produced.

which intersect when produced.

Reid's Geometry of Visibles.

All this was stated long ago by Reid, in his "Geometry of Visibles," and has often been stated since. But it has been stated in that form of needless paradox, which tends to obscure truth at once to those who are urging it and to those whom they address. It has been said that if we had no geometrical conceptions except what came to us through the sense of sight, it would appear to us that parallel straight lines could, and if produced must, enclose a space. Now, the accurate way of making this statement is, that if we had no geometrical conceptions except what we acquired through the sense of sight, we should have no conception of straight lines at all, but of great circles instead.

These remarks will show us what to think of the following puzzle—for it is really no better—from "Essays by a Barrister:"—

A Barrister's puzzle

"It would also be possible to put the case of a world in which two lines would be universally supposed to include a space. Imagine a man who had never had any experience of straight lines through the medium of any sense whatever, suddenly placed upon a railway stretching out on a perfectly straight line to an indefinite distance in each direction. He would see the rails, which would be the first straight lines he had ever seen, apparently meeting, or at least tending to meet, at each horizon; and he would thus infer, in the absence of all other experience, that they actually did enclose a space when produced far enough."

The answer to this is, that what he would *see* would not be two straight lines, but arcs of two great circles, each of the arcs being nearly, if not quite, a semicircle; and, I suppose, he would have no reason to *infer* anything else.

CHAPTER XXXVII.

THE RELATION OF THE MIND TO SPACE AND TIME.

IN the last chapter, I have endeavoured to show that our first rudimentary knowledge of space consists in the cognition of sensations as being situated in different parts of the body, and consequently related to each other in space. It seems inconceivable that the existence, at the same time, of sensations in different parts of the sentient organism should not give rise to a rudimentary cognition of space; whether these are sensations of pressure or of heat in different parts of the skin, or sensations of colour in different parts of the retina. And besides, as I have shown, this theory of the origin of the cognition of space accounts for the fact, that our spontaneous thoughts of space or extension are more apt to be of a surface than of either a line or a solid.

Our knowledge of time is a primary cognition: we cognise time in cognising our sensations as successive.

It is not disputed by any, that our knowledge of time is an immediate and primary cognition; that is to say, we become cognizant of time in the act of cognising our feelings as succeeding each other in time. But concerning our cognition of space there is great diversity of opinion. One school, which I believe is the prevalent one in Germany, and with which I agree, maintains that the cognition of space is equally immediate and primary with that of time: in other words, that as we cognise time by the succession of sensations in time, so we originally cognise space by the separation of sensations in space. This is a statement, though too brief to be complete, of the theory on the subject which I have endeavoured to prove in the last chapter. Another school,

I believe space is cognised in a parallel way.

Opinion that space is cognised by motion only.

to which Mill, Bain, and H. Spencer belong, think that the knowledge of space is obtained solely by moving in it; and as all motion takes place in time, they infer that our knowledge of space is not a primary cognition at all, but derived from that of time. As I have said, I am opposed to this view. In the last chapter I have stated my reasons for thinking that the cognition of space is primary. Nevertheless there are real arguments on the other side, which must be fully stated before they can be refuted.

In approaching the question whether our knowledge of space is really a primary cognition like that of time, we first meet with this fact, that whether time and space are considered in themselves or as objects of thought, they are in many important respects like each other, and unlike anything else. Considered in themselves, they are both infinitely extended, and both infinitely divisible. Magnitude is expressible in terms either of time or of space. Both have being, though neither has existence; all things exist in space, and all events occur in time. Considered as objects of thought, they are both necessary; that is to say, we cannot conceive them as not being. We can voluntarily form a mental conception of the absence of all existing things, but empty space will remain: we can similarly conceive the absence of all events, but time will remain. We cannot conceive, by any effort of the mind, of a limit to either: we cannot conceive of a boundary in any direction to space, nor can we conceive of a beginning or an end to time.[1] In one way, indeed, the idea of space appears to cling closer to the mind than that of time; for although magnitude may be expressed in time as well as in space, we habitually think of magnitude rather as

Similarity of space and time.

Both are necessary.

Magnitude is more naturally

[1] Mr. ill says it is *credible* to him that there may be a limit to space (though of course he admits that it is *inconceivable*), and I suppose he would say the same of time. I do not agree with him; but I mention this in order to point out that *conceivable* and *credible* are words and ideas which ought never to be confounded;—though it is one of the most important of all metaphysical problems, to determine how far conceivableness is a test of possibility and credibility. I do not mean to charge Mr. Mill with any such confusion; on the contrary, I do not think I could name any writer who is so free from it.

expressed in space than in time. Thus, we speak of a *space of time*, but not of the converse: we never speak of a *time of space*. On the other hand, we speak of numbers in terms of time, even when the numbers indicate ratios between spaces; thus we say that the sun is *many times* as far off as the moon. From these facts, as well as from those dwelt on in the last chapter concerning our cognition of space, I conclude that our knowledge of space and our knowledge of time are distinct in their origin, and parallel, though closely connected, in their development.

expressed in space than in time: though number is expressed in time. Conclusion that the cognitions of the two have separate origin.

It may be said that all this is irrelevant. It may be said that the mere examination of our habitual thoughts throws but little light on their origin, just as the anatomy and physiology of a mature organism may throw but little light on its larval form and on the mode of its development. I formerly thought this argument was valid, but I have in a great degree been compelled to modify my opinion, in consequence chiefly of the very remarkable manner in which our thoughts of space actually do, as I have shown in the last chapter, retain traces of their mode of development, and of what, by a bold but perfectly accurate metaphor, I may call their larval form. The larval form of our cognition of space is derived from touch and from the motions of the hand only; in its developed form it is derived from these conjointly with sight. Now, as I have shown, we spontaneously think of space in terms of linear magnitude, which are given by the hand, and not in terms of angular magnitude, which are given by the eye. This is a very decided remnant and record of the origin of our cognition of space by touch, and not by sight. If it were true that the cognition of space were developed out of the cognition of time, we should surely find some such evidence as this of its development; but we find none such. Time is linear, and so is motion;[1] and if our cognition of space were developed by means of motion out of our cognition of time, we surely should think more easily and more spontaneously of a line

Is the argument relevant? Reason fo thinking that it is. Larval an mature forms of these cognitions.

[1] It may be said that rotatory motion is not linear, but angular. But rotatory motion may always be resolved into linear motions.

than of a surface: but, as we have seen, the reverse is the case.

Reason advanced for thinking that the cognition of space is from motion.

The reason usually advanced in favour of the theory that the cognition of space is not primary, but derived from that of time through the means of motion, is, that motion is capable of producing it, and that no cognition ought to be regarded as primary if it can possibly have been derived from any other. I have stated my reason for thinking, in opposition to this theory, that our mode of thinking of space is different from what it would be if it had been produced in that way. But in my opinion the really strong reason for thinking that the cognition of space is somehow less of a primary cognition than that of time, is the fact, of which every one must be aware who has read or thought on the questions of modern metaphysical controversy, that there is something perplexing, something, it may be said, unmanageable, in the relation of the mind to space, which there is not in its relation to time. And, argue as we may, we cannot get rid of the fact, that time is much more inseparable from our thoughts than space. It is true, as already remarked, that we cannot conceive of a universe without them both. But it is also true that we think in time, and do not think in space; and we cannot by any process of reasoning get rid of the notion that "the external world" does exist in space, in a sense in which the same is not true of "the internal world:" or, in other words, that space is somehow external to the mind. These facts convinced me, when my attention was first directed to this class of subjects, that the cognition of space was formed in the mind later than that of time, or, at least, must be formed in a fundamentally different way; and I am inclined to think that these facts are what really determine such thinkers as Mr. Mill, though it may be in some degree unconsciously to themselves, in favour of the theory of our knowledge of space being altogether acquired by means of motion. It is unquestionably true that, in the way I have just stated, the relation of our consciousness to space is unlike its relation to time. But this fact will, I think, lose its force if it can be shown to

Time is more inseparable from our thoughts than space.

belong, not to consciousness as such, but, as it were accidentally, to the human consciousness, as a consequence of the manner in which the human consciousness is developed out of its original germ of sensation. I believe this can be shown. I think it can be shown how the human mind has been developed under circumstances which have caused its relations to space to be unlike its relations to time; and it can be further shown with great probability, how a mind might be developed, quite consistently with what we know of the laws of mental development, under circumstances which should cause its relations to space to be the same as its relations to time; or, in other words, how a mind might be developed which should think, not only in time, but also in space.

I believe this is not essential to all mind, but accidental to the human mind.

All consciousness is primarily consciousness of difference. This, I believe, is admitted by every one. That is to say, if the mind were to be always feeling the same sensation, it would never be conscious at all; but consciousness is awakened when sensations begin, or cease, or succeed each other. As a matter of fact, I think it is certain, and will be disputed by no one, that our consciousness is developed in this way. But let us see how much is implied in this. In order to cognise the difference between two sensations succeeding each other in time, it is necessary to remember the first of the two; that is to say, it is necessary that the consciousness of the first sensation should outlast the sensation itself.[1] Consequently, a rudimentary memory is necessary to the development of consciousness *in time*. Now, I have just admitted that *our* consciousness is unquestionably developed in time. But is it a necessary consequence of the laws of mind that *all* consciousness must be developed in time? I think we may assert with some tolerable degree of certainty that a mind might be developed, under the same laws as ours but under other circumstances, from the thoughts of which space and time should be alike inseparable, which should think in space as well as in time. For, why do *we* think in time and not in space?

Our consciousness begins with the succession of sensations.

Possibility of consciousness being developed in space as well as time.

[1] See pp. 70, 71.

The fact that we do so, though it is a fact of consciousness, is, I think, not an ultimate fact, but one that admits of being accounted for. In order to account for it we must go beyond the general fact that consciousness is developed out of sensation, and examine the constitution of the separate sensory faculties.

Touch, sight, and hearing minister to mind.

The sensory faculties which we have to examine are only the three intellectual senses; that is to say, touch, sight, and hearing: for these are the only senses which, in man at least, have any appreciable effect in producing mental development.[1] Now, it needs no proof that it is only touch and sight which give rise to any cognition of space (including the muscular sense as belonging to touch). Hearing alone could not give it. But, in compensation for being unable to cognise space, the sense of hearing has the remarkable power, in which it differs from all the other senses, of cognising different simultaneous sounds without their combining into one; that is to say, of cognising sensations as distinct which are sensations of the same sense, and are not separated either in time or in space; and not only of cognising them as distinct, but of either attending to one of them in preference to the others, or else of attending to several at once, so as to cognise their mutual relation.

Of these, only the first two give cognition of space.

Time is cognised by all the senses, because all sensations succeed each other in time; but space is cognised only by touch and sight. This fact—that time is cognised by all the senses, and space by only some of them—is, I think, enough to account for the fact that we think in time, and not in space. But this is not all. That intellectual sense which gives no cognition of space—namely, the sense of hearing—is of all the senses the most closely associated with thought. This is probably a consequence of the habit of thinking in words, which is necessary to any high development of thought. It is also to be observed that sensations of different senses are cognised either as simultaneous or as successive. If, for instance, we see a flash and hear a shot, we are conscious of hearing the shot either at what

Hearing is the most closely connected with thought, because we think in words.

Sensations of different senses may give

[1] See the Chapter on the Senses (Chap. XXXV.).

appears to be the same time with the flash, or at a sensibly later moment, so that sensations of different senses give a cognition of time; while only sensations of the same sense, whether of sight or of touch, are able primarily to give any cognition of space.[1] There is thus quite enough in the constitution of the sensory faculties of man to account for the fact that we think in time and do not think in space, and that time is inseparable from the human consciousness, while space can only be thought of as something external to it. There is enough, I say, in the constitution of our sensory faculties to account for these facts, without the aid of any such hypothesis as that of the conception of space being derived from the conception of time by means of the experience of motion.

cognition of time, but only those of the same sense can give it of space.

But these, though facts of *our* consciousness, are not necessarily facts of *all* consciousness. I have said above that we may conceive of a being having its consciousness developed in space as well as in time, and consequently thinking in space as well as in time. Such would probably be the result if a mental nature as complex and lofty as ours were developed, as it conceivably might be, out of the germ of the sense of sight alone. We must suppose such a being to have no sensations whatever except those of light and colour; so that either it had no visceral or organic sensations at all, or, if it had any, that they took the form of sensations of colour, as jaundice is said (though, I believe, erroneously) sometimes to give a yellow colour to everything that is looked at. Such a being could not conceive of a sensation without its having position in space; for every colour that is seen must of necessity be seen in some position in space. The consequence of

Case of a mind developed out of the sense of sight only:

[1] It may be said that a sensation of sight and one of touch are cognised as related to each other in space: for instance, I both see and feel the paper on which I am writing, and cognise its position by means of both sensations. This is true: but, as stated in the last chapter, we have every reason to believe that the power of identifying a visual object with a tangible one is an acquired power. If we had never seen anything that we felt, and had never felt anything that we had seen, the idea of identifying the objects of sight and of touch would not occur to us as a possible or conceivable idea.

its consciousness would be developed in both time and space.

this would be, that its consciousness would be developed in both space and time, just as our consciousness is developed in time only. All *our* sensations have position in time, but only some of them have position in space. The sensations of hearing—which, as we have seen, is the sense which is the most intimately connected with thought—are not primarily in any way related to space; and consequently *our* consciousness is developed in time, and we think in time, but we do not think in space, and space appears to our consciousness to be somehow outside of it. But in the supposed case of a being which is unable to have, and consequently unable to conceive of, any sensations except such as have position in space, the mind would be developed in space as well as in time. It would think both in time and in space. Space would be as inseparable from its thoughts as time is from ours, and would not appear to be in any way outside of its consciousness. The relation of its consciousness to space would be no more perplexing to it than the relation of our consciousness to time is to us. Indeed, the development of its consciousness in space would be a simpler fact than the development of its consciousness, or of our consciousness, in time; because, as we have seen, consciousness cannot be developed in time without at least a rudimentary memory, so as to cognise the difference between present sensations and past ones: but nothing similar to this is needed in order to cognise either the relations of likeness and unlikeness, or the space-relation. Our consciousness may be called a series of feelings strung together on a thread of time;[1] but the consciousness of such a being as we are supposing—a consciousness into which space enters as inseparably as time—might rather be called a series of feelings woven, as a pattern, into a web whereof the warp is time and the woof is space.

Illustration.

If it is asked what I mean by thinking in space?—how is

1 But, as Mill has remarked, if the mind is a series of feelings, it is a series which is aware of itself as a series. I agree with Dr. M'Cosh that this is an inadequate statement, but I doubt whether Mill means it as an exhaustive one.

it conceivably possible to do so?—I reply, that we think in time by means of words which succeed each other in time. If we were naturally, spontaneously, and unavoidably to think by means of diagrams drawn in space, I should call this thinking in space. This, of course, is not a full account of a subject which, by the terms of the case, lies in a great degree outside of our possibilities of thought; I only offer it as a suggestion or indication.

What is meant by thinking in space.

It may be said, in answer to this reasoning, that I have, at the most, proved the possibility of consciousness being developed in space and in time at once; but that, if I would complete my argument as to the difference between the relation of time and of space to the human consciousness being only, as it were, accidental, and not a law of all consciousness,—in order to complete this argument, I say, it may be urged that I ought to show the possibility of consciousness being developed in space and not in time, as a parallel and an opposite to the development of the human consciousness in time and not in space. This, however, is a demand which cannot be complied with. The very fact of our consciousness being developed in time makes it impossible for us to conceive the possibility of a consciousness which is not developed in time. But though it is not imaginable by us, I do not see any impossibility in a consciousness being developed in space and not in time: that is to say, I do not see any impossibility in the consciousness of some totally different order of being becoming awakened into life—not, like ours, by the succession of different sensations, each occupying a distinct portion of time, but by the co-existence of different sensations, each occupying a distinct portion of space. I say, that I see nothing absurd or incredible in a consciousness being in this way developed in space; while the sensations, being perfectly unchangeable, do not give rise to the development of consciousness in time. Indeed, the one essential condition of the origin of consciousness, as it appears to me, is neither the cognition of the succession of sensations in time, nor the cognition of their separation in space, but simply the cognition of difference: whether

Possibility of a consciousness independent of time.

difference of opposition in space, or difference of position in time, or difference in the sense of unlikeness. But though the notion of a consciousness which is not developed in time, and which remains unchanged through time, is not capable of being imagined by us, whose consciousness has been developed in so totally different a manner, yet the possibility of it is capable of being believed. It has been a favourite notion with some Christian mystics, that the happiness of a future state may be a perfectly unchangeable state of bliss, so as to exclude all sense of the succession of feelings, and consequently all consciousness of time. This notion has been thus expressed in the well-known lines—

Instance of this being believed in.

> "Nothing there is to come, and nothing past,
> But one eternal NOW doth alway last."

I quote these, not as having myself any sympathy with the feeling they express, but merely in order to show that the notion of a consciousness which does not exist in time has proved itself before now to be believable.

CHAPTER XXXVIII.

TIME, SPACE, AND CAUSATION.

IT will be perceived by any one who has followed my reasonings thus far, that, as regards the relation of the mind to space and time, I assent to the theory which is associated with the name of Locke, namely, that our knowledge of them is derived from experience, in preference to the theory which is associated with the name of Kant, of their being *à priori* forms of thought existing in the mind previously to experience, though it is only by means of experience that the mind becomes conscious of them. I see no reason whatever for thinking that the conceptions of space and time exist in the mind in any form at all, consciously or unconsciously, previously to experience. In a word, I think with Locke, that experience is what produces those conceptions; in opposition to Kant, who maintained that experience does not produce them, but only calls them forth from unconsciousness into consciousness.

I hold the experience theory of our knowledge of space and time, in preference to that of forms of thought.

But the doctrine of Locke, which I adopt, must be understood with a very important modification. The conceptions of space and time are indeed results of experience; but it is, for the most part, not individual but inherited experience: in a word, they are *results of the experience of the race, which have become forms of thought for the individual.*

But the experience is inherited: so that the results of the experience of the race become forms of thought for the individual.

Thus Locke, who derived our conceptions of space and time from experience, and Kant, who regarded them as forms of thought, are seen to be both right; but the truth seen by Locke is a wider truth than that seen by Kant, and includes it. The reconciliation and union of the two,

Herbert Spencer.

by introducing the conception of hereditary mental habit, is due to Herbert Spencer, in whose work on Psychology the subject is wrought out. I believe that his doctrine will, in another generation or two, be universally accepted, and that the age-long controversy on this subject will cease.

The problem stated: How have space and time become forms of thought? Is the fact ultimate, or a result of experience?

It is not to be denied that space and time *are* forms of thought: the question is, how space and time have become forms of thought. Kant replied to this question by simply stating the fact, and stating it as an ultimate and inexplicable one. Locke and Spencer, like Kant, admit the fact; but, unlike Kant, they do not regard it as ultimate and inexplicable; they believe, and I agree with them, that it is a result of experience acting through the law of hereditary mental habit.

The experience theory.

The doctrine that the conceptions of space and time are results of experience is often, and conveniently, called the experience theory. The doctrine that they are ultimate and inexplicable laws, or forms, of thought, is often, and

The ideal theory.

conveniently, called the ideal theory; and it forms a characteristic part of those metaphysical systems which are known as the various forms of Idealism or Transcendentalism; the essential character of which, if I understand them aright, consists in regarding mind as the fundamental reality, and in deriving all knowledge from the constitution of the mind itself.

The ideal theory was consistent with the psychology of Kant's time.

Kant's ideal doctrine, that space and time are not only forms of thought but *à priori* forms—inexplicable facts of mind not to be accounted for by experience, or accounted for at all,—this doctrine, I say, was quite consistent with the psychology of Kant's time, which regarded mind as something totally distinct in nature from the matter and the organic life with which it is always associated. When space and time were *found* to be forms of thought, and when thought was *supposed* to be something apart from the external world, it was a logical inference that these forms of thought belonged to the mind only, and could not be traced to any origin in the external world. And it was a further inference, not very obvious, but logical and perhaps

necessary, that space and time are nothing but forms of thought, to which there is no corresponding reality in the world outside of the mind; that though we are compelled by the constitution of our faculties to perceive, and to think of, objects in space and events in time, yet space and time are in no way functions of the objects and of the events, but solely of the mind which cognises them. Kant saw this inference, and admitted it. But now that we have learned to regard thought, not as something apart from the external universe, but as the highest manifestation of its highest forces—namely, those of life—it is an equally logical inference, and is the inference which I draw, that space and time are forms of thought *because* they are facts of the universe; that they were facts of the universe before they became forms of thought; and that, in a word, they are facts of the universe which have become conscious of themselves in the brain of man.

Further conclusion, that space and time are unreal,

admitted by Kant.

The experience theory is consistent with our psychology.

It appears to be a prevalent notion—though it was the notion rather of the schools of Kant and of Coleridge than of those which have succeeded to them—that idealism, or the theory which makes time and space, and other conceptions that belong to the groundwork of our thoughts, to be *à priori* forms having no root except in the mind itself, and consequently derives all knowledge from the constitution of the mind;—it appears, I say, to be a prevalent notion that idealism is somehow more favourable to faith than the rival experience-theory. I think this is not only wrong, but the exact reverse of the truth. If space and time, and other fundamental conceptions, are nothing but forms of thought, to which nothing in the universe around us necessarily corresponds, then they are, or may be, totally unreal; and absolute truth—that is to say, truth which is true for all natures whatever—is unattainable by us, and perhaps has no existence. Kant did not draw this conclusion—his faith kept him from it; but his philosophy did not constitute a basis for his faith: on the contrary, it was his faith that kept him from what he saw and admitted to be the logical consequence of his philosophy.[1]

Notion that idealism is favourable to faith.

I think the reverse.

Kant was kept from scepticism by his faith, in spite of his philosophy.

[1] See Note at end of chapter.

But if it is true, as I believe, that these conceptions were facts of nature before they became forms of thought, and are forms of thought because they are facts of nature, then it follows that the forms of thought correspond with the facts of external nature: we know things as they are; our knowledge of the universe, though very limited, is real so far as it extends. So that idealism, with all its vast pretensions, leads by a direct and logical path to absolute scepticism; while the experience-theory, though it is comparatively unpretending, and is often despised as being materialistic, is at least a possible basis for belief.

The experience theory makes our knowledge to be true though limited, and is a possible basis of belief.

I now come to the subject of causation. I believe that we acquire the knowledge of causation in exactly the same way in which we acquire the knowledge of space and time, namely by direct cognition—by their coming within the sphere of consciousness.

Causation, like space and time, is cognised directly, by coming within the sphere of consciousness.

I have already stated[1] my belief that we acquire our first cognition of space from the co-existence of sensations in different places in the body; and that we acquire our first cognition of time by the succession of sensations. In the act whereby the mind cognises the separation of sensations in space, space comes within the sphere of consciousness; in the act whereby it cognises the succession of sensations in time, time comes within the sphere of consciousness. I believe that we acquire the cognition of causation in an exactly parallel way to these; namely, by the relation of cause and effect entering into the sphere of our consciousness. Consequently, our first knowledge of causation is not merely inferential knowledge; it is matter of direct cognition, as much as our knowledge of likeness and unlikeness, of succession, and of the space-relation. But there is this peculiarity about the cognition of causation. The other three simple relations which I have enumerated obtain between sensations; and in cognising them the mind may be perfectly passive. But with causation the case is different. One sensation cannot be cognised as the cause of another: when we are cognizant

[1] In the Chapter on Mental Development (Chap. XXXIII.).

of causation taking place within the sphere of our consciousness, the effect is not a sensation, but either a thought, a mental feeling, or a voluntary determination; in the production of any of which the mind must be in some degree active. In a word, we become cognizant of causation in becoming conscious of our own mental action. I do not see how this fact of a direct cognition of causation within the mind itself can be doubted. I was conscious, for instance, of a feeling of joy at the result of the Abyssinian war. I was conscious of assenting to the reasoning by which, as stated above, H. Spencer has explained the origin of our conceptions of space and time as results of hereditary habit. And since the commencement of this work, I have often been conscious of voluntary determinations, or determinations of my will, to think and to write on its subjects: these determinations are not mere feelings, but feelings followed by action; and I am directly cognizant of the connexion between the determination as the cause and the action as its effect.

Causation is cognised in becoming conscious of mental action.

I must here guard against a probable misconception. We are directly cognizant of the relation of cause and effect only when both the effect and the cause are within the sphere of consciousness. Thus, when I determine to think out a particular subject, and do so, I am directly cognizant of the causation; that is to say, I am directly cognizant of the fact that the determination of my will is the cause of the direction of my thoughts. But when I write, I am not directly cognizant of my will as the cause of the motion of my fingers, because the connexion between the will and the muscular actions is not within consciousness. It was maintained by Wolf, the expositor of Leibnitz, if he is not misrepresented, that the determinations of the will and the motions of the muscles are not related as cause and effect, but that the mind and the body are so constructed as to act together without any such connexion; and, absurd as is such a theory, it does not actually give the lie to consciousness. So far as I can perceive, our only, though quite sufficient, reason for believing that our muscular actions, such as the motions of the fingers in

There is no direct cognition of the will as the cause of muscular action.

writing, are caused by our voluntary determinations, is that we always find that the voluntary determinations are followed by the motions. But if any one were to tell me that hearing good news is not the cause of joy, or that my reading a sound demonstration is not the cause of my assenting to it, this would contradict a fact of direct cognition, just as much as if he were to assure me that sugar was bitter or toothache pleasant.

How we learn to identify physical and mental causation as cases of the same law.

We say that fire causes heat, and that good news causes joy. Fire causing heat is a fact of matter; and this relation of cause and effect is not within our consciousness, but is, as I believe, inferred by us from the facts. Good news causing joy is a fact of mind; and this relation of cause and effect is within our consciousness, and is, I think, self-evidently no mere inference, but a fact of direct cognition. But mankind naturally and spontaneously regard these as both alike cases of causation; and I believe that here, as in so many other cases, the spontaneous belief of mankind is right. But how do we come mentally thus to ascribe the same law of causation to these two sets of actions, the physical and the mental, between which there is so little intelligible resemblance? I think, though the subject is most difficult to analyse, that the connecting link by which we learn to identify causation as cognised within the mind with causation as inferred in the world of matter outside of it, consists in the fact that we have the power, inexplicable as that power is, of making our own will an acting cause in the world of matter. Thus, if I will to think, my thoughts act as desired; if I will to write, my fingers and my pen act as desired; and though the causal connexion, as already pointed out, is within the sphere of consciousness in the one case and not in the other, yet the effect follows the cause in both cases with equal certainty, and we learn to identify the nature of the causal action in the two cases. In a word, we identify the two facts of mental causation and physical causation in consequence of the fact that a mental determination is capable of becoming a physical cause; as when the determination of my will causes the

motion of my pen. If a being were to exist, having powers of perception and thought like our own, but without any power whatever of acting on the world around it, I think it is certain that its ideas of causation would be very unlike ours. It would have exactly the same idea of causation that we have, in the sense in which causation is resolvable into mere "invariable and unconditional sequence;" but it would have no idea of causation in the sense of force; and force, as it appears to me, is the essential thing in our idea of causation.

Imaginary case of a being with thought but no motor powers.

It will be seen that in this account of our original cognition of the relation of cause and effect, I ascribe it to experience, although I differ from Mill and the rest of those who regard causation as nothing more than "uniform and unconditional sequence." I agree with them in ascribing it to experience; but they ascribe it to experience of the facts of the external world which we observe; I ascribe it to experience of the facts of the mind, of which we are directly cognizant. When we say, for instance, that "fire is the cause of heat," we state a fact which we have learned purely from external observation. But Mr. Mill maintains that when we say that "fire is the cause of heat," our only meaning is, that "fire always emits heat, and nothing more than the fire itself is needed in order to have heat." I think, on the contrary, that more is meant than this. I think we apply the analogy of our own mental experience to the external world, and infer that fire causes heat in the same sense in which good news causes joy, or evidence causes belief. It may be said this analogy is plausible only to that intellectual state in which men try to explain the facts of the external world by the fancies of their own minds. I think, on the contrary, that the rejection of this analogy belongs to that exploded system of psychology in which mind and matter were regarded as distinct and totally unlike substances. The progress of science has gradually brought us back to the spontaneous conclusion of the earliest conscious thought, before metaphysics were invented; namely, that the mind of man is not distinct from the material world in the

Where I agree with Mill, and where I differ.

midst of which it is placed, but is the highest product of the forces of that world; and what we have discovered concerning the dynamics, both of inorganic matter and of life, makes it highly probable, if not indeed quite certain, that in every physical and every mental change there is some transformation of energy.

Summary. To sum up in the fewest words possible the results of this chapter:—Time, space, and causation are facts of the universe which have become forms of thought in consequence of coming within the sphere of our consciousness. Our conceptions of time, space, and causation are results of the experience of the race which have become forms of thought for the individual.

Belief in the infinity of space and time.

But though I believe this account of the matter to be true so far as it goes, I do not think it exhausts the question. Any account of our conceptions of time and space, if complete, ought to explain why we believe in the infinity of both. Those who regard these conceptions as mere results of experience, say that we have never found any limit to space, and are therefore unable to conceive of any; and that we have never found an end of time, and are therefore unable to conceive of any. I cannot, however, think this satisfactory. We believe that time is alike without end and without beginning; and any theory of the subject ought to account for this twofold belief. Now the pure and simple experience-theory does not account for this. It accounts for the belief that time is without an end, by the fact that we have never had experience of any portion of time without another portion of time coming after it. But this will not apply to our belief that time is without a beginning; for the first time that any one's consciousness was awakened, he had at that moment experience of a portion of time without having experience of any other portion of time coming before it; so that, for anything that mere experience can witness to, there is nothing inconceivable in a beginning of time.[1] I think

Difference between our belief of an eternal past, and of an eternal future.

[1] This difference has been pointed out to me in conversation by my friend the Rev. Dr. Reichel, Vicar of Mullingar.

this is conclusive proof that, although we obtain our first knowledge of time by direct cognition, and it has become a form of our thought by hereditary habit, yet there is something in our knowledge of its properties for which mere habit will not account, and which can be referred only to that mental intelligence which is not a result of habit. If this is true of the conception of time, it is no doubt equally true of the conceptions of space and of causation.

This mental intelligence is to form the subject of the next chapter.

NOTE.

THE PHILOSOPHY OF KANT.

I SHALL probably be told that I have misunderstood Kant's philosophy; and I admit that, like most of those who write about him, I have not any knowledge of his works at first hand. But I believe I am right. The system unfolded in his "Critique of the Pure Reason" is one of absolute idealism, deriving all the principles of knowledge from the constitution of the mind: this is, and Kant perceived it to be, logically identical with pure scepticism, or that system which denies the possibility of our really knowing anything except that which passes within the mind. It is true that, in his "Critique of Practical Reason," he arrived at a different conclusion, and showed how faith was possible. But I believe I am right in saying that his "Pure Reason" is in no way a basis for his "Practical Reason;" that, on the contrary, his "Practical Reason," though of course it speaks in a philosophical language, is in reality nothing else than faith, building itself up in spite of the sceptical conclusions of the pure reason, or faculty of speculative philosophy.

The system of Kant's "Pure Reason" is idealism, identical with scepticism: that of his "Practical Reason" is faith.

CHAPTER XXXIX.

MENTAL INTELLIGENCE.

The most important question of biology is whether intelligence is a primary fact.

IN my opinion, the most important question now under discussion in the sciences of life and mind, and I think I may add the most important question that ever can be debated in those sciences, is this:—Is intelligence an ultimate primary fact, without physical cause, and without any cause except Creative Power; or only a resultant, put together out of unintelligent elements by the action of the laws of habit? In the chapter on Natural Selection I have argued, in opposition to the theories of Darwin and H. Spencer, that the organizing intelligence which adapts one part of the organism to another is an ultimate fact, not to be accounted for, as those most able writers endeavour to account for it, by the principles of habitual self-adaptation and natural selection. In this chapter I shall have to argue the same of mental intelligence,—namely, that it is an ultimate fact, not to be accounted for by the laws of habitual association. In the chapter on Intelligence,[1] I have given my reasons for believing that organizing intelligence and mental intelligence are only different manifestations of one principle. Possibly, not many of my readers will agree with me in this; but it is most probable that all who think with me as to the primary and independent nature of intelligence in either of these two cases will agree with me in the other case also. It is, however, necessary to argue the question of the nature of organizing intelligence, and of mental intelligence, on totally different grounds. The argument as to the latter is, at least to me, the most difficult; but this is not because I think it less

I have argued the affirmative of organizing intelligence, and have now to argue it of mental.

Difficulty of the

[1] Chapter XXVII.

certain; it is only on account of that peculiar difficulty which arises when thought becomes the object of thought, and which makes metaphysics so difficult and, in the eyes of most men, so unsatisfactory a study. latter question.

None of the materials of our thoughts are innate in the mind; they are all either the direct results of experience, as when we remember what we have seen and heard; or else they are the results of the mind's activity in working with the results of experience, as when we infer and imagine. For, as I have already pointed out, the mind possesses no really creative power; it can only combine and recombine. And, as I have shown in the last chapter, I believe not only the materials of thought, but also such forms of thought as time, space, and causation, to be results of experience. Thus all thought begins from data of experience. But we have the power of reasoning, and reasoning truly, from these data to conclusions that lie beyond experience. Thus, for instance, the whole science of geology, as distinguished from its mere facts, consists in a mass of inferences, from the data that are visible in the rocks, concerning the state of the earth before man lived to witness it; many of which inferences admit of no more reasonable doubt than do the events of the history of last year. Now, what is the nature of the intelligence which makes these inferences? Is it only a resultant from the laws of habitual association; or are its principles (to use, I believe, Coleridge's expression), not the result of experience but implied in experience? I am of Coleridge's opinion. I believe that in the simplest inference an element of intelligence is needed, which is not a result of experience; or, in other words, not to be referred to the laws of habitual association. There are no innate ideas. Thought begins from experience. Element of intelligence in all thought which is not a result of experience.

The laws of association will account for much. In the chapter on Mental Growth I have endeavoured to show how, as I believe, the laws of memory, acting by association, account for such a mental process as that of learning our own or another language; and I believe that the laws of association are quite sufficient to account for the origin of our *conceptions*; but that they utterly fail to account Association will account for con-

ceptions, but not for beliefs.

for our *beliefs*. In other words:—The laws of association will account for the origin of our thoughts, considered merely as thoughts; but not for the belief that a thought corresponds to an external reality.[1]

Belief in the constancy of the order of things.

One of the most important of all our beliefs is the belief in the constancy of the course of external things; or, as it is usually expressed, the belief in the uniformity of nature. We instinctively believe that fire will always be hot, ice always cold, and food always nourishing; or, to use general terms instead of instances, we believe that the same or similar things will continue to have the same properties, and the same or similar causes will continue to have the same effects. All reasoning from known things to unknown is based on this expectation; not only reasoning from the past to the future, but all reasoning from known things to unknown, whether the unknown things are future, as when we endeavour to foresee the weather: present, as when we reason concerning the internal constitution of the earth; or past, as in geological questions. The axiom implied in all these three cases alike is, that the order of nature has been, is, and will be constant; there is no doubt this axiom is implied, and there is no doubt that it is true; the question is, how we acquire our belief in it.[2]

How is this acquired?

Some say by habit only.

The most obvious answer to this question, and one which has moreover satisfied many philosophers, is that this belief is a mere consequence of experience, producing mental habit. We have always found the order of things constant, and we therefore expect to find it so.[3]

I think this is no explanation.

I do not wish to speak dogmatically on so controverted a point, but this appears to me no explanation at all; or, what comes to the same thing, it is an explanation which

[1] See Note A at the end of this chapter.

[2] See Note B at the end of this chapter.

[3] Experience is what produces mental habit. Consequently, the theory referred to in the text is sometimes called the experience theory, sometimes the association theory, or, as I prefer to call it, the mental habit theory. The expressions are practically synonymous; for experience and habit are only the opposite sides of the same fact; experience being the external or objective side, and habit the internal or subjective.

takes for granted that which is to be explained. The question is, how are we able to reason from the known to the unknown?—why we believe, and truly believe, that it is practicable to apply data of experience to things of which we have no experience? And the answer is, that we believe in the accustomed order of nature obtaining among the things we do not know, because we are familiar with it among the things that we do know. Surely this is no explanation at all. It is worth while, however, to look more closely into the question. To say that the belief in the constancy of the order of things is due to habit, is the same thing as to say that it is due to association; for association is simply mental habit. Now, how can the mere association between two ideas, of itself, produce a belief in the association between the corresponding things? No doubt it appears to do so, but this, I think, is only because the axiom of the constancy of the order of things is habitually and unconsciously assumed. For what is the law of association? As stated in a former chapter, it is merely this: if any two things, such as lightning and thunder, have been habitually united in our experience, the ideas of them will become united in our thoughts, so that if we see lightning we shall think of thunder, and if we hear thunder we shall think of lightning. But the thoughts of lightning and of thunder are mere impressions on the consciousness: and how can the association between two mere impressions, however inseparable it may be, engender the belief that the things in the external world to which those impressions on the consciousness correspond will be found in corresponding association? There is a step from thoughts to things, from the association of ideas to a belief in the association of the things corresponding to the ideas, for which, I think, no mere laws of habitual association will account.

It may be said in reply to this, that, as a matter of fact, belief is in many cases obviously determined by habit, and by no other cause whatever. Most men have beliefs, especially on religious and political subjects, which have no ground whatever except habit, originating usually in

Belief is subject to the laws of habit, but habit cannot produce belief.

education. This is true: but it only shows that belief, like every other mental function, is subject to the laws of habit, and consequently that particular beliefs may be determined by habit; it does not show that the laws of habitual association are capable of accounting for the general fact that the mind is capable of forming beliefs.

Physical analogy.

This distinction may appear strained, but it is capable of being illustrated by an analogy drawn from the simplest of the physical sciences. The action of all forces is governed by the laws of motion, and yet the laws of motion will not account for the origin of force; just so, the formation of beliefs, like all other mental actions whatever, takes place subject to the laws of association, and yet it does not follow that association is of itself able to produce belief.

It may be asked whether we should have this confidence in the constancy of the order of things, if the order of things were not constant? To this I reply that I regard this supposition as not only imaginary but impossible: of the same kind of impossibility, I mean, as if it involved a mathematical absurdity. I shall have to show the grounds of this opinion further on.

But, it may be said, the constancy of the order of things is not perfect; it is perfect in the motions of the heavens, but imperfect in the changes of the weather. This is true in a very obvious sense; and it would not be altogether relevant to reply, what is nevertheless true, that the bond of cause and effect is, beyond all reasonable doubt, as real and as rigid in atmospheric changes as in the celestial motions, only less traceable. I reply, that in the sense in which I speak of the constancy of nature, irregularly succeeding phenomena are as much an instance of it as regularly succeeding ones. From the fact that the changes of the weather are irregular, we have learned to expect that they will be so; and this is a case of expecting that what has been found true in the past will continue to be found true in the future.

Objection from the inconstancy of the weather answered.

The constancy of the order

It may be said that my argument assumes the constancy of the course of things to be as certain as the

axioms of mathematics; whereas it is not certain, but only highly probable. It is highly probable that the sun will rise to-morrow; it is so probable that we are right in acting as if it were an absolute certainty; but it is not so certain that the sun will rise to-morrow as it is that he rose to-day; and it cannot be regarded as even highly probable that the course of nature will continue to go on for a thousand millions of years longer.[1] I reply, that all this is true; nevertheless, it is as certain as the axioms of mathematics, that the course of nature will go on until it is interrupted by some cause not now in operation. The law of causation, which is a part of the law of the uniformity of the order of things,[2] is only that the same antecedents will continue to be followed by the same consequents; but it cannot guarantee that the antecedents will continue to be the same. Our knowledge of things is but finite, while our ignorance is infinite; and we must consequently regard all known lines of causation as being liable to be cut through by unknown ones.

of things is not certain, but only probable:

but it is certain to be constant unless interrupted.

Of course the truth that all causes in the natural world act regularly, so that their action is in its nature capable of being predicted,[3] is not by any means self-evident; on the contrary, it is a discovery due to the progress of science. But the belief that every effect must have a cause is, I think, universal among men, and among animals which

In what sense the law of

[1] I believe that the attempt to find a numerical value for the probability of the sun rising to-morrow is one of the idlest of all amusements. At the best, it is an attempt to arrive at a conclusion for which there are no possible data. But I am inclined to agree with Mr. Venn, the author of "The Logic of Chance," that in such a case the expression "numerical value of the probability" has no meaning at all.

[2] The uniformity of the order of things includes uniformities both of co-existence and of succession; it is only those of succession that belong to causation. By uniformities of co-existence I mean, that the same substance will always have the same properties; as, that ice, at a temperature below freezing, will always be hard and brittle. By uniformities of succession I mean, that the same causes will always have the same effects; as, that heat will melt ice. These two classes of uniformities run into each other, as the instances just mentioned show. I doubt whether there is any really fundamental distinction between them.

[3] This truth is what Mill, in his Logic, means by the law of universal causation.

causation is self-evident.

manifest any germ of conscious intelligence; being implied in their universal expectation that what has been found true in the past will continue to be found true in the future.

From all this I conclude, that our instinctive confidence in the constancy of the order of things is not due to habit, but is an ultimate fact, belonging to mental intelligence. If this is so, it follows that in every determination to action there is an element which is not a result of habit; for all actions whatever, and all feelings that have reference to action, such as desire and fear, presuppose the belief in the constancy of the order of things. The desire of a hungry man or animal for food, and the proverbial dread of a burned child for the fire, presuppose the belief that food will continue to satisfy hunger, and that fire will continue to burn; and such belief, as I have stated my reasons for thinking, belongs to intelligence.

This confidence is presupposed in action, and in desire and fear.

The principle of confidence in the order of nature, however, does not enter into all our thoughts; it does not, for instance, so far as I can see, enter into mathematical reasoning. The only principles which, so far as I see, enter into all reasoning without any exception whatever, are those of logic; and when I speak of reasoning, I include not only abstract reasoning, but simple inference, including perception, which, as I have argued in the chapter on that subject, is an inference. In all reasoning whatever, the elementary axiom of logic is assumed; namely, the axiom that a contradiction cannot be true; or what is called, in the technical language of logic, the principle of identity and contradiction. All beings that are capable of inferring and of perceiving know that this is true, though they may be unable to express it; there is no question either of the universality of the belief or of its truth; but how has it been acquired? I have argued that mental habit or experience cannot alone and of itself produce belief in the constancy of the order of nature, or any belief at all; and if my reasoning is valid for the belief in the constancy of the order of things, it is equally valid for the belief in the

The only principles which enter into all reasoning are those of logic.

universal and necessary truth of this logical principle. Indeed, the argument is stronger for the belief in the impossibility of a contradiction being independent of experience and antecedent to it, than for the belief in the order of nature being independent of experience; for our belief in the order of nature is merely that it is and will be constant, so long as no cause occurs to disturb it; but our belief in the impossibility of a contradiction is without any such qualification; under no circumstances, and in no world, can it ever be possible for a contradiction to be true. This belief, I think, cannot be the result of habit, and can only belong to intelligence.

These are known by intelligence without habit.

Further: I maintain that the perception of things external to ourselves is an inference from our sensations. It is obvious that, once the idea of an external world has been suggested to us, the belief in its existence receives confirmation at every moment. But what first suggested the idea of an external world? The process of inference involved in perception may be thus expressed:—"This sensation has not its source within me; it must therefore have its source outside of me." This is obviously a particular application of the law that a contradiction cannot be true; for it would be a contradiction if the source were at once within and without.

They are involved in perception.

The logical principle of identity.

But this is not a full account of the subject: for, why do we take for granted that sensations must have a source at all? or, in other words, why do we refer sensations to their objects? This is only a particular way of asking the question, what is the nature and meaning of our idea of substance? Mr. Mill defines matter as a "permanent possibility of sensation:" which is obviously true, but, I think, inadequate as a definition; just as it would be an inadequate definition of the mind, or the conscious self, to call it a permanent liability to sensations and other feelings.[1] In becoming conscious of our own feelings, we

The idea of substance.

[1] Mr. Mill (Examination of Sir William Hamilton's Philosophy) defines matter as "a permanent possibility of sensation;" but he goes on to say (though not in these words) that it would not be an adequate definition of

become conscious of a self which has the feelings, and yet *is not merely the sum-total thereof*;[1] and in inferring the *existence of an external* world we infer, as I think, the *existence not only of "permanent possibilities of sensation," but of objects* to which we refer the sensations.

Axioms of metaphysics.

I regard the following as axiomatic truths:—1. That where there are properties there must be substance; 2. where there is relation, there must be things related; 3. where there is action, there must be an agent; and I am inclined to add, as a truth belonging to the same category, 4. that where there is an effect there must be a cause. The question whether we have any idea of substance as distinct from mere permanence is a parallel one to the question whether we have any idea of causation as distinct from mere succession. In the last chapter I have stated my belief that our idea of causation is not resolvable into mere succession. I regard the four metaphysical axioms stated above, like the logical axiom that a contradiction cannot be true, as necessary truths of intelligence; and the belief in them is a result neither of mental habit, nor of inference from data of experience; on the contrary, it is implied in all thought and all experience, and without it neither thought nor experience would be possible.[2]

Beliefs not the results of thought but implied in thought.

Belief in the veracity of memory

Further: we have a belief in the veracity of memory; that is to say, we believe that as perception gives us true information of present reality, so memory gives us true information of past reality. It is to be observed that the belief in a past reality as corresponding to an impression of memory is not implied in the mere presence of the

mind to call it a permanent liability to feeling. I think this inconsistent: but it is not the result of any oversight on Mr. Mill's part.

[1] "Cogito, ergo sum," said Descartes: not meaning by this celebrated saying to prove his own existence, which neither needs proof nor admits of it; but to state the truth that it is in the act of thinking we become conscious of our own existence.

[2] It is scarcely necessary to remark, that the belief, or knowledge, of these truths is not necessarily conscious knowledge, and does not imply the power of stating them in words. Men were not conscious of knowing them till they had begun to think about thinking.

impression of memory; for a doubt often arises whether such an impression is really due to memory or only to involuntary imagination. It is generally admitted, and is I think indisputable, that this confidence in the veracity of memory is an ultimate fact, not to be accounted for by any other, or in any way explained. Its root and origin is no doubt in the cognition of feelings as they follow each other in the mind; but this is no more an explanation of the fact, than it would be an explanation of the life of a plant to trace it back to its seed. Now, a belief which, like the belief in the veracity of memory, is an ultimate fact of mind and not to be accounted for by the laws of habit, is to be classed as a case of mental intelligence.

is an ultimate fact,

and belongs to intelligence.

In thus expressing the opinion that the belief in the laws of logic, the belief in the constancy of the order of nature, and the belief in the veracity of memory, are not results of experience, but *à priori* conditions of all thought, without which impressions on the consciousness would be nothing higher than sensations, and could not give rise to knowledge—in expressing this opinion, I say, it may be thought that I am bringing back, under a slightly different form, that doctrine of idealism which I have disavowed in the last chapter. I do not deny the apparent resemblance of my theory to idealism, but it is only apparent. Idealism—at least the idealism of Kant—maintains that such forms of thought as time, space, and causation belong to the mind, and not to the external world. I believe, on the contrary, that such forms of thought as time, space, and causation; and such natural beliefs as the belief in the laws of logic, and in the constancy of the order of nature; are laws of mind because they are laws of the external world;—I believe they are laws of nature, which have become conscious of themselves in the brain of man. In the last chapter I have endeavoured to explain by what means time, space, and causation have come within the sphere of consciousness, and consequently, from being laws of the external world, have become habitual forms of thought. If the reasoning of this chapter be sound, the

Resemblance of my theory to idealism,

and its difference.

I believe the laws of thought are so because they are laws of nature.

same explanation will not apply without modification to the belief in the laws of logic, in the constancy of nature, and in the veracity of memory; for these are not results of habit, but of intelligence, antecedent to any possible formation of mental habits whatever. There is, however, no contradiction. To repeat the distinction which I made at the beginning of this chapter, our *conceptions*, among which I class those of time, space, and causation, are due to habit; but *belief* implies intelligence. But in the formation of both conceptions and beliefs the mind is developed in accordance with the laws of nature, and the laws of nature become conscious of themselves in mind. In other words, mind is a part of nature, and consequently its consciousness is developed in accordance with the laws of nature.

The question, should we expect to find nature constant if it were not so, is irrational.

It follows from this, that the question whether we should expect to find the order of nature constant if it were not really constant, is an irrational question; for if the order of nature were not constant, our minds, being part of the order of nature, would have received a totally different development, and another set of intuitions, from those which they actually have received.

Intelligence is co-extensive with life,

To my conclusion that mental intelligence is an ultimate fact, not to be accounted for by the law of habit, or accounted for at all, it is no objection that animals manifest it in some degree; for, as I have in many places endeavoured to show, intelligence is co-extensive with life: and the organizing intelligence which adapts each part of the organism to the rest, and the entire organism to its mode of life; the instinctive intelligence which constructs the cells of the bee; and the mental intelligence of man; are all fundamentally the same. Intelligence is not always conscious, and even when conscious it is not always conscious of itself; indeed, I believe there is something unconscious about all thought, except that which is formally logical.

and not always conscious.

Summary.

To sum up the result of the foregoing remarks: I believe that all mental determinations which go beyond the mere

remembrance, association, and recombination of ideas, and involve belief in things external, in things past, or in things future, imply intelligence as an ultimate irresolvable fact. Belief implies intelligence,

The rudimentary form of belief in things external is perception. The rudimentary form of belief in things past is memory. Belief in things future is expectation. I consequently conclude, that in the simplest act of perception, memory, or expectation, an intelligence is implied which is not the result of experience, but is a necessary condition of the acquisition of experience; just as in every act of organic nutrition and growth an organizing power is at work, which is not a result of the physical and chemical properties of the food that supplies the materials for building up the organism, but which is a necessary condition of all nutrition and growth. But it must be remembered that intelligence is not necessarily conscious; on the contrary, it admits of all degrees from perfect unconsciousness to perfect consciousness. as nutrition and growth imply organizing power.

In the biological chapters of this work, I have several times dwelt on the fact that the evidence of organizing intelligence is the strongest where the organization is the highest—stronger, for instance, "in insect's wing or eagle's eye," than in any part of a tree or of a zoophyte. No proof is needed for the parallel fact in psychology—the fact, namely, that the higher the mental nature, the greater is the influence of intelligence, and the more decided its domination. Intelligence dominates most in the highest life, both organic and mental.

In conclusion, I have to make some remarks on the peculiarities of the mind of man, as distinguished from the minds of the highest animals. So far as I am able to perceive, there is not any single principle to which the whole of man's manifold superiorities are to be traced. I have already expressed my opinion that what is most characteristic of the moral nature, namely, the sense of holiness and of its opposite, sin, is due to a peculiar spiritual intelligence in man, distinct in kind from any principle of organic or animal intelligence, and having no Peculiarities of the mind of man. Sense of holiness.

root therein.[1] But the intellectual superiority of man is due, as I think, to quite a distinct cause,—namely, the power of directing thought at will; on which depends the power of forming abstractions, and thence the power of abstract reasoning, which is the distinctive power of the human intellect; for animals are capable of the mental process which I have elsewhere called simple inference.

Power of directing thought at will.

There is, however, another distinctive character of the mind of man, which is not identical with the powers just mentioned, though probably closely connected with them: I mean the faculty of self-consciousness. The higher animals are conscious, but only man is conscious of self: the higher animals think, but only man is conscious that he thinks, or can think about thinking. The symbol of this consciousness of self is the use of the personal pronouns; and in their use is displayed, I think, a higher kind of intelligence than any animal ever attains to, and an intelligence, moreover, which is demonstrably not a result of mere habit. A child learns to call itself *I* and *me*, no doubt, by imitating other persons who call themselves so; and once begun, the use of those words, as of any other words, becomes habitual. But the personal pronouns, at least those of the first person, differ from all other words in this, that the child applies all other words to the same objects to which it has heard them applied by others; but it applies the words *I* and *me* to an object—namely, itself—to which it has never heard them applied by others; so that it appears impossible for the meaning of *I* and *me* to be learned by mere habitual association, in the same way that the meaning of other words is learned. The meaning of the words *dog* and *cat*, for instance, is learned by their association with the objects dog and cat; and the names of persons are learned in the same way. But the meaning of the words *I* and *me* cannot be learned in this way, because the child never hears them associated with its own self; always with other persons' selves. It learns to use them, no doubt, by imitation; but how does it know what to imitate?

Consciousness of self.

Use of the personal pronouns.

[1] See p. 64.

The power of perceiving the peculiar relations expressed by the words *I* and *me* can only, I think, be ascribed to an unconscious exercise of that intelligence which is not a result of habit; and, though unconscious, it leads to the subsequent development of that consciousness of self whereof those pronouns are the symbol.[1] Intelligence needed for this.

I have now completed the part of this work which treats of the laws of life and mind. My purpose has not been to write in any way a complete treatise, but only to trace the laws of Habit, and their relation to Intelligence; and to show the primary and irresolvable nature of the latter.

NOTE A.

BAIN'S THEORY OF BELIEF.

On the subject of our belief in the constancy of the order of nature, Professor Bain says: "The foremost rank among the intuitive tendencies involved in belief is to be assigned to *the natural trust that we have in the continuance of the present state of things*, or the disposition to go on as we have once begun. This is a sort of law of perseverance in the human mind, like the first law of motion in mechanics. Our first experiences are to us decisive; and we go on under them to all lengths, being arrested only by some failure or contradiction."[2] The italics are Professor Bain's. Quotation from Bain.

This is very like an admission that the belief in the constancy of the order of nature is an ultimate fact, not to be resolved into any law of habitual association. His theory of belief, however, is that belief is a result of habitual association, with the addition of an active element. Now, I think it is true, and an important truth, that belief, and every other intelligent function of the mind, involves the exercise of its active powers, and is not to be His theory of belief

[1] This is clearly and forcibly stated, though from a point of view somewhat different from mine, in Professor Ferrier's Introduction to the Philosophy of Consciousness.

[2] The Emotions and the Will, 2d edit. p. 537.

accounted for by any modification of its passive capacity for feelings. But this is not what Professor Bain means. Stripped of its verbiage, his theory of the subject seems to me to come to nothing more than this: *the germ of belief in anything consists in readiness to act on that belief;* and this is no explanation at all. I do not even admit that readiness to act on a belief has necessarily anything to do with the first rudimentary formation of belief, or with the origin of the power of believing. The belief that wherever there are properties there must be substance, for instance, appears to me to contain no active element whatever in Professor Bain's sense. This argument, however, is of no weight in the estimation of Professor Bain and the school to which he belongs, as they reduce the idea of substance to that of mere permanence.

is no explanation.

Belief in substance.

Mill on Bain.

Mr. Mill, in his review of Professor Bain's work on the Emotions and the Will,[1] truly remarks that belief is the great difficulty of the (exclusive) association theory; that is to say, the theory which would account for all the facts of mind, other than mere sensations, by the laws of association alone. He does not express any decided opinion as to Professor Bain's success in solving the difficulty. I think belief is not the *difficulty* of the association theory, regarded as a complete and exclusive theory, but its *refutation.* I think, as I have already stated, that habitual association will account for the origin of our conceptions, but not of our beliefs; or, to use what is perhaps more accurate language, that the laws of habitual association will account for the power of conceiving, but not for the power of believing.

Bain on the belief in the veracity of memory.

If I understand Professor Bain, he goes so far as to argue that the belief in the veracity of memory is not an ultimate fact, but produced in the same way in which (according to him) any other belief is produced; that is to say, that belief in the veracity of memory is, in its germ, *readiness to act on the belief that things are as we remember them.* I think this is open to the objection that it is an explanation which takes for granted the thing to be explained. Of course the truth of a belief in the veracity of memory, or in anything whatever that is past, or future, or external, can be *tested* only by its agreement with facts. But this does not account for its original formation; and I think the only possible germ, or root, of the belief in the veracity of

[1] Mill's Dissertations and Discussions, vol. iii.

memory is the perception of the succession of feelings in the mind. I do not say the succession of feelings, but the perception of their succession.

Mr. Mill, in his "Examination of Sir William Hamilton's Philosophy," says that "the belief in the veracity of memory is evidently ultimate." If this is so, why may not other beliefs be ultimate as well? Mill on the same.

NOTE B.

MILL'S INDUCTIVE LOGIC.

Mr. Mill, in his "System of Logic, Ratiocinative and Inductive," accepts the usual doctrine, that there are two kinds of reasoning: the one, inductive or analytic, ascending from particulars to generals; the other, deductive or synthetic, descending from generals to particulars. But he maintains also that the original and elementary form of reasoning is neither from particulars to generals, nor from generals to particulars, but from particulars to particulars; as when a child, or a dog, infers that the fire which has burned it once may be expected to burn it again. Inductive and deductive reasoning. Reasoning from particulars to particulars.

As a mere statement of fact, this is perfectly true. It is true that men reason, and reason correctly, from one fact to another, before they learn either to infer one general truth from a number of special facts by induction, or to apply one general truth so as to prove other less general ones by deduction. But this is not a *rationale* of the process. Mr. Mill is well aware, and pointed out long before the present work was thought of, that all reasoning concerning things involves the axiom that the course of nature is uniform; or, as I have purposely expressed it in less scientific language, that what has been found true once will probably be found true again. I quote his own words: "If we throw the whole course of any inductive argument into a series of syllogisms, we shall arrive, by more or fewer steps, at an ultimate syllogism which will have for its major premiss the principle, or axiom, of the uniformity of the course of nature. Having reached this point, we have the whole field of induction laid out in syllogisms, and every instance of inference Quotation from Mill.

exhibited as the conclusion of a ratiocination, except one; but that one, unhappily, includes all the rest. Whence came the universal major? What proves to us that nature is governed by general laws? Where are the premises of the syllogism of which this is the conclusion?"[1]

Question of the origin of the belief in the constancy of nature.

It is perfectly true that the constancy of the order of things cannot be proved by any deductive or syllogistic reasoning. Mr. Mill thinks that our belief in it is due to association, or mental habit. I have stated, in the foregoing chapter, my reasons for thinking that it is an ultimate fact of intelligence.

[1] Logic, vol. i. p. 373, note.

CHAPTER XL.

HABIT AND VARIATION IN HISTORY.

I HAVE in the foregoing chapters traced the outline of the sciences, or rather the single science, of life and mind, regarded as consisting of various and manifold applications of the two principles of Habit and Intelligence. That science, though at present in a state of very rapid advance, is fully systematized; a vast number of its problems remain to be solved, but a fundamental revolution in the mode of conceiving of the problems appears as totally impossible in the science of life and mind as in dynamics or in astronomy. The same is true of all the mathematical and physical sciences. I hope to show in a future chapter that there is a perfect series of sciences, from abstract logic, through mathematics, physics, and chemistry, to the sciences of life and mind. The ground-plan of this series has been so well laid, as regards both the principles of the sciences themselves and their relation to each other, that the work can never by any possibility have to be done over again. The outline has been drawn, and what remains to be done consists exclusively in filling it up.

The science of life and mind has been fully systematized, as have also been logic, mathematics, physics, and chemistry:

But there is another group of sciences which have not yet been thus systematized. No doubt they admit of systematization, but the time for doing this work is, perhaps, not yet come. The sciences I speak of are those whereof the subject-matter consists of the results of the activity of the human mind, and the laws by which the mind acts under particular conditions. I cannot attempt even a complete enumeration of this group of sciences:

but the sciences of the results of man's mental activity have not yet been systema-

tized, including those of language, art, and society.

but the most important, or at least those which have been most nearly reduced to systematic form, are the science of language; the science of the fine arts, or æsthetics; and the science of society, or politics.

The laws of these subjects depend on the laws of mind, but the converse is not true.

The subjects of these three sciences—that is to say, language, art, and human society—are all products of the mind of man; and, consequently, their elementary laws must depend on the laws of mind, while the laws of mind do not in any degree depend on them. So that these sciences depend on psychology in somewhat the same way that biology depends on chemistry, or dynamics on mathematics. The manner in which the principles of language, art, and society depend on the laws of mind can be best shown by taking those three sciences separately.

In language are an intelligent and an habitual element.

First, as to language. In all mental action whatever, as I have endeavoured to show in the last chapter, there is an habitual element and an intelligent element, which, though they may be separated in thought, are always combined in fact. Language, being a product of mental activity, may be expected to show manifest traces of these two factors; and such is the case. It would be superfluous to argue for the obvious truth that all language involves an habitual principle: we learn to use language by habit, and by habit alone. But it is also obvious that all language, at least when it is used as the means of the most elementary reasoning, involves a logical principle: and if the conclusions of the preceding chapter are true, the logical principles that all thought involves belong to intelligence, and not to habit. But without going back on that metaphysical question, it is obvious that the power of learning words by memory, and the power of combining them into sentences that have a meaning, are two totally distinct powers; and even those who do not agree with me as to the absolute and fundamental difference between Habit and Intelligence, will agree that the distinction between the two in the use of language is real, and of great importance. We may briefly say—though, perhaps, not with perfect logical accuracy—that memory supplies the words, and intelligence combines them. A person

without intelligence might know the names of things, but he could not combine the words into sentences having a meaning; and this, I believe, is the case with some idiots. A person without memory, on the contrary, might conceivably think, but for want of knowing the necessary words he could not express his thoughts in words. Memory and intelligence are thus both necessary to the use of language; and as memory is a case of habit, it follows that habit and intelligence co-operate in the use and in the formation of language just as they do in organization and in mind. I think this cannot be disputed, whatever may be our conclusion as to the ultimate nature of intelligence; but in the present state of the science of language it is not so evident as it will be at some future time. The science of comparative grammar has not as yet got beyond comparative etymology; the students of the science are at present concentrating their whole attention on the habitual element in language, namely the words; this is needful at present, and may probably continue to be so for a long time. But it may not always be so; a science of comparative syntax will surely be possible, so soon as materials enough have been accumulated. By the formation of such a science the logical element in language will be brought into the same prominence, and may, perhaps, come to be as well understood as the habitual, or verbal, element is now. I do not think it is too much to hope that some fellow-countryman of Bopp and Grimm, or perhaps of Sir W. Hamilton or of Professor Boole, may yet so trace the connexion between the laws of language and the laws of logic as to throw light on both. I am not able to make a beginning at that subject. I go on to show how very close is the resemblance between the action of the habitual principle in organization and in language.

Comparative grammar is as yet only comparative etymology, but comparative syntax is to be hoped for.

Language is an organism. This is no mere metaphor. The definition of an organism is that it consists of parts which are all in functional relation to each other; and the words of a sentence are thus functionally related.

Language is an organism.

Organization is not the cause of life, but life is the

As life constructs the organism, so thought constructs language.

cause of organization. High organization is, however, necessary to any high development of life: life constructs the organism to be at once its dwelling and the means of its action. Just so, language is the result of thought, but a highly developed language is necessary to any high development of thought: thought has constructed the organism of language in order to use it as an instrument. Considering the unlikeness between the subjects of the analogy, the analogy itself is wonderfully close between the action of life in building up the organism, and the action of thought in constructing language: each forms an organism to be its instrument.

Variability of language, both in the forms of words and their meanings,

All habits are gradually variable; and habits of using particular words are peculiarly so: that is to say, the words themselves are variable. Words vary both in their forms and in their meanings. I have argued in the earlier part of this work, that the characters of organic species are variable, with little or no limit as to amount of change, if only time enough is allowed; and that all organisms which are morphologically similar, are so by reason of being descended from the same ancestors. If this is true, any difference between parts which are morphologically the same—as, for instance, between the leg of the dog and that of the horse—are due to variation in the course of their descent from their common ancestor; and such

comparable to variations in the forms of organs,

variation is a parallel fact to the variation that takes place in the form of words when a word which is fundamentally the same is found in different languages. No one doubts, for instance, that the German word *heide* and the English *heath* are forms of the same word, and that the similarity of the two is due to their common Gothic original. I believe that the modifications, both in the organisms and in the words, are due to modification in the course of descent or derivation; and that both, consequently, are alike cases of the variation of habit. We usually speak of the *descent* of living races, and of the *derivation* of words; but it is not a violent metaphor to speak of the *derivation* of the former and of the *descent* of the latter.

Words also change their meanings, even within the

limits of the same language, while their forms remain;[1] and this has its parallel in the fact that organs frequently assume new functions, while their form and structure undergoes but little change, as in the case of those fishes whereof the swim-bladder, without differing much from that of other fishes, assumes the function of lungs. This analogy, or a similar one, is carried much further than we might have expected to find it. We have seen that some animals have rudimentary and totally useless organs, such as the leg-bones of some serpents and the wing-bones of the wingless birds, the only intelligible explanation of which consists in the supposition that they are inherited from ancestors which had the corresponding organs in a developed and working state.[2] These rudimentary organs have been compared to the silent letters used in spelling many words, especially in French and in English. This analogy is not merely fanciful, but real. The silent letters were once sounded; so the rudimentary organs were once, as I believe, developed and at work. The silent letters mark the origin of the word; so, as I believe, do the rudimentary organs mark the descent of the species; and, as all naturalists admit, they mark its true affinities.[3]

and in their functions.

Rudimentary organs

comparable to silent letters.

Further, there is another very curious parallel between the laws of organic morphology, and the laws of what

[1] As the strangest instance of this that I can think of, I will mention the word *implicit*. *Implicit* is properly opposed to *explicit*, and means *implied* as opposed to *expressed*: but implicit faith and obedience have come to mean blind faith and obedience. The history of the change in the meaning of the word is this, that implicit faith became a theological expression, signifying the faith which a man was credited with having in a doctrine to which he was too ignorant to attach any meaning, provided he believed in the authority of the Church, on the authority of which the doctrine was to be believed. Thus, a man who was too ignorant or too stupid to know what the Church taught on the subject of transubstantiation, would nevertheless be credited with implicit or implied faith in that doctrine, provided he only believed that the Church which taught it could not err.

[2] See the chapter on Comparative Morphology (Chap. XX.).

[3] I believe the time will come before very long, when it will be generally admitted that the descent of a species is what constitutes its affinities; and that affinity in classification has no meaning except community of descent.

may, by a very slight metaphor, be called the morphology of language. We have seen that there are some morphological characters in organisms which are due to laws of correlation merely, and appear to have nothing to do with the adaptation of structure to function. Such are the facts that in umbelliferous plants there is the same deeply cloven or branched structure in the leaves and in the inflorescence; and that in man there are five toes on each foot as well as five fingers on each hand. It is as impossible to assign any purpose for these correlations as it would be to assign a purpose for the laws of crystalline formation; they are not adaptations, they are nothing but correlations.[1] There are in some languages correlations which may be compared to these: the best instance is that of the inflections of Greek and Latin adjectives, which contribute nothing to the meaning, and are only added from a principle of correlation with their substantives. The analogy, I think, is perfect. The logical principle in language corresponds to the adaptive principle in organization; and we find that there are correlations in organization which are not adaptations; and correlations in language which have nothing to do with meaning, and consequently nothing to do with the logical principle; they both consist in a kind of symmetry, which appears as if it were sought for, not as a means but as an end.

Morphological correlations independent of function,

comparable to inflections without meaning.

Since the study of organic morphology and the study of language have both become truly scientific, the analogy between them is really very remarkable. Both have become comparative studies: the decisive step which first made the study of language really a science was taken when the study of comparative grammar, or comparative philology, was commenced: a science of language was impossible, so long as its data were obtained from only one or two languages. In exactly the same way, the only scientific morphology is that which is based on the comparison of forms which are widely different, but not so different as to exclude a fundamental resemblance. And

Morphology and the science of language are both comparative sciences,

[1] See the chapter on Morphology (Chap. XIX.).

the more profoundly both comparative morphology and comparative grammar are understood, the more fundamental resemblances do their students discover under the external appearance of total unlikeness. The science of language also resembles morphology in being a science of progressive change. I do not say of development or of embryology, because we know nothing yet, as far as I am aware, about language in its embryonic state; though the embryology of language, that is to say the history of its origin and earliest development, would be a subject of science, and a most interesting one, if the facts could be ascertained. But as morphology traces not only the graduated resemblances and differences between different species and different classes, but also the progressive changes during the life of the individual; so the science of language traces not only the graduated resemblances and differences between the same or allied words in different languages, but also the progressive changes in the same language from century to century, amounting sometimes to total apparent transformation—such as, to mention one of the most remarkable of all perfectly well-known cases, the transformation of Latin into French.

and sciences of progressive change.

The embryology of language is yet unknown.

The same remarks apply, without more modification than the difference of the subjects renders necessary, to the science of the Fine Arts. I speak of the scientific study of their history: their theory is a different subject. Concerning the theory of the Fine Arts not much is yet established, with the exception of the theory of music, which is well understood, at least in a technical sense; but though there must be a profound connexion between the laws both of visual beauty and of music with the laws of mind, yet the laws of this connexion have not yet become a subject of science, and consequently we have not yet any science of beauty; nor have we as yet, in the truest sense, a science of those arts—namely, the Fine Arts—which consist in the embodiment of man's ideas of beauty through the action of his intelligence. But a scientific

Historical science of the fine arts,

involving the same principles

as organic morphology and language.

treatment of the history of art is possible; and it is found to involve the same principles that obtain alike in organic morphology and in the science of language. In art, we have to do with comparative morphology, and with development and progressive gradual change. It is no

Morphology of art.

metaphor to speak of morphology in art; the word is applicable with the most perfect literalness to those arts of which the object is form: architecture is perhaps the best instance. In any historical account of a style of architecture, or in any comparative account of styles which are not too unlike for comparison, especially if they have a common origin, it would be almost impossible to avoid the use of language which sounds as if it were borrowed from organic morphology. Thus, in describing the

Its progressive changes.

English architecture.

progressive changes of the architecture of England, we say that from the time of the introduction of the pointed arch, by which the Gothic style was constituted as a distinct style, arches gradually became flatter, mouldings less bold, and ornaments more elaborate. Or in tracing the *descent with modification* (and in the word descent is implied an analogy with living beings),—in tracing the

Roman, Gothic, and Oriental architecture.

process of descent, I say, by which the Roman architecture was modified into the Gothic on the one side, and into the Oriental or Saracenic on the other, we find that the arch, which was semicircular in the Roman style, became pointed in the Gothic, and in the Oriental acquired the "horse-shoe" form, or, in other words, became a somewhat greater arc than a semicircle. We use exactly the same language when we describe how the leg of the quadruped is so modified as to be changed into the wing of the bat or into the paddle of the whale; and all these changes, those of organic morphology and the morphology of art alike, as well as the changes of language, come under the one law of the gradual variability of habit. This, I think, is self-evident, if once the origin of species by descent with modification is admitted.

There is no doubt this difference, that changes in organic morphology are due to the action of totally unconscious forces, and changes in language are due to mental forces

acting with very little consciousness; but changes in styles of art are made with full consciousness on the part of the artist. This difference, however, is not fundamental, if it is true, as I have elsewhere argued,[1] that organizing intelligence and mental intelligence are essentially the same. The love of slight novelty for its own sake,—though an unintelligent principle, is probably the moving or impelling power, though not the controlling one, in the progress of art, in the direction both of improvement and deterioration; without this, I mean, art would be either quite stationary, or subject to very few and slight changes; and this love of slight novelty, as I have already remarked, is probably very closely connected with the law of the gradual variability of habit.[2] On the other hand, the continuity which is so remarkable in the history of art,—without which, indeed, art could not be said to have a history at all,—this continuity, I say, is due to the constancy of habit, and to the mental law that great or sudden changes are disagreeable. It may be said that in point of fact the history of art is less continuous than I have stated it to be. I do not deny that the history of art presents some very remarkable instances of rapid, if not quite abrupt change. Some of these, however, are cases merely of the introduction of a foreign style which has superseded the native one, as when the pointed Gothic architecture was introduced from France into Western Germany, and rapidly and completely superseded the old round-arched style. Others are due to the introduction of new materials or of new necessities: I shall have to mention a very remarkable instance of this kind further on. But the total change in English architecture from the round-arched Norman of Glastonbury to the Early Pointed of Salisbury is not to be thus accounted for. It appears to be a case of almost total transformation, effected without any extraneous cause, and in a very short time.[3] But this does not violate—on the

Love of novelty is the moving power in the progress of art.

Habit is the reason of continuity in the history of art.

Rapid changes in art.

Substitution in England of Early Pointed for Norman.

[1] See the chapter on Intelligence (Chap. XXVII.).

[2] See the chapter on the Laws of Variation (Chap. XVI.).

[3] I believe this change nearly coincides in date with the transformation of the Norman kingdom of England into an English one.

This is probably paralleled in the development of species.

contrary, it completes—the parallel between the history of the morphology of art and that of the morphological changes in the development of species, if it is true, as I have maintained in a previous chapter, that organic changes must have taken place at particular periods with exceptional rapidity.[1]

Intelligence in art modifying the materials given to it by unintelligent habit, without violating the consistency of a style.

I have stated that although there is beyond doubt an intelligent, or logical, principle in language, yet in the present state of the science of language we know very little of the mode of its action. It is otherwise in the history of art: in the morphology of art, as well as in organic morphology, the action of intelligence is clearly traceable in modifying the results of unintelligent habit. I have shown in a previous chapter how the organizing intelligence works with the materials given to it by hereditary habit, so as to modify for new purposes what is homologically the same organ, and yet so as to retain a much closer resemblance to the original model than is needed for the new purposes; as is seen, for instance, in comparing the wing of the bat with the leg of the quadruped.[2] This action has its parallel in the history of art, where the artist's purpose, which is the intelligent principle, modifies the action of the habitual principle of traditional style. The best, or at least the most curious instance of this that I know of, is the way in which the Gothic style of architecture was modified, without losing its distinctive characters, in consequence of the introduction of stained glass; the display of which, without injury to the other beauties of the style, became the object of the Gothic architects.[3]

Instance in the modification of Gothic architecture for the display of stained glass.

Politics.

The principles of the science of life and mind are still more remarkably applicable to politics, or the science of human society.

It has become a commonplace, that "constitutions are not made, but grow;" the same is true of language, of art,

[1] See the chapter on the Rate of Variation (Chap. XXVI.).

[2] See the chapter on Comparative Morphology (Chap. XX.).

[3] See Fergusson's Illustrated Handbook of Architecture, vol. ii.

of society, and of every product of human activity continued through successive generations; though it is not necessarily true of the product of the activity of a solitary worker or thinker. This truth is a result of the fundamental truth, that habit is variable, but only gradually so. All the historical researches of the last half-century tend to show, more and more clearly, the continuity of all history, and the impossibility of any progress which is not gradual. Destructive changes, no doubt, may be sudden, and so may death; but constructive changes must take place under the laws of life, and must be gradual, because they involve, or consist in, changes of habit. It has been said, with a basis of truth, though with much exaggeration, that

Continuity of history, and gradualness of political growth, are consequences of the law of habit.

> "A thousand years scarce serve to form a state,
> A day may lay it in the dust."[1]

Constructive changes cannot be at once profound and sudden; when they are unquestionably sudden and appear to be profound, as in the revolutions which we have lately witnessed in Italy and in Germany, their profundity can only be tested by the durability of the result; and if it stands this test, we may be sure that such a revolution, however sudden it may seem, has been prepared for by a gradual change in the minds of men. It is indeed a commonplace that all political change, if it is to be durable and safe, must be gradual; that constitutions must develop themselves, and must take time to do so. This is a consequence of the law of the gradual variability of habit; and in speaking of political or constitutional growth or development, men almost unconsciously use a metaphor taken from the science of life.

We thus see that the law of the gradual variability of habit is that which underlies the analogous facts of organic morphology, of language, of the history of art, and of political history.

Gradual variability of habit, in morphology, language, art, and history.

These analogies are very wide and general. I now go on to the subject of a remarkable special analogy, also

[1] Byron.

Analogy of political progress to mental education.

based on the law of habit, between the process of mental education and that of social and political progress.

All education consists in the formation of habits, and the acquisition of any new power as the result of education consists in the exercise of that power becoming habitual, and in a great degree independent of consciousness and will. Thus, the process of learning one's own or any other language consists in the words and their meanings coming to suggest each other without any effort of thought, so that the reasoning process which is needed in order to understand or to form a sentence is in a great degree, if not altogether, performed in unconsciousness. By thus learning to perform as a result of unconscious habit what at first needed a conscious effort of will and thought, the immediate work to be done—whether forming a sentence, or practising an art, or whatever it may be—is done much more rapidly, while the attention is set free for other purposes. Learning an art, or a language, occupies the whole attention—that is to say, according to what I think is the correct definition of the word attention, it absorbs the whole consciousness in so far as the consciousness is under the control of the will; but when the art has been thoroughly learned, it may be practised while a large share, if not the whole, of the attention is left at liberty to direct itself to other objects. Thus, a competent artisan is able to converse while at his work, unless it is in any way exceptionally difficult. And for the same reason it is, I believe, comparatively useless to most persons to read books of information or of reasoning in a language with which they are not sufficiently familiar to read it without effort;—the language absorbs too much of the attention to leave enough of it free for the subject of the book.

Both consist in the formation of habits.

It is a parallel truth to this, that social and political progress mainly consists in the formation of social and political habits, of which laws are in a great degree the expression; and this progress is possible only on condition of actions becoming habitual after they are once decided on. It is, for instance, very important to have a good par-

Necessity of permanence in habits.

liamentary constitution, but it is quite as important that its merits should not be constantly under discussion. Other legislation would be impossible if Parliament were always engaged in discussing projects for the reform of itself, just as the exchange of ideas would be scarcely possible if we had to be always thinking of the grammatical construction of our sentences. In a word, as education is possible only by actions becoming habitual, so political progress is possible only on condition of institutions becoming in some degree permanent. They are the greatest of political *bores* who think every opportunity a right one for opening a discussion on the merits of any institution whatever, though the instinctive conservatism of mankind generally prevents them from being dangerous.

Political bores.

All this is obvious enough. There is another parallelism, between the mental development of the individual and the progress of society, which is equally real though not so obvious. It is a truth on which I have insisted in the biological part of this work, that the conscious functions are in all cases later developed than the unconscious ones, and are developed out of them; and it is scarcely a metaphor to say that this is true of political development also. Society acts unconsciously before it learns to act consciously. Government at first springs up spontaneously; nations at a later period learn to appoint their governments by a conscious and deliberate act; but the appointment of a government by a conscious national act would never have become possible, and indeed could not have been thought of, if governments had not first grown into existence as a natural development of paternal authority.[1] The same is true of the origin of law. It is a truth which must be understood in order to make primitive history intelligible, that *custom is older than legislation*:—laws originate unconsciously in custom before they can be consciously modified by legislation; and legislation would be impossible if it had not a basis in customary law. This ought to be easily intelligible to those who live under the English system of law, in which common law has, or at

Conscious functions are later developed both in the individual and in society.

Government.

Law.

[1] See Maine on Ancient Law, chapter v.

least is supposed to have, its origin in immemorial custom, older than any statute.[1]

Habit ought to be controlled by intelligence.

Moralists constantly warn us against the dominance of habit, and politicians warn us against blind conservatism. They are right. Habit is an unintelligent force, and ought to be kept as far as possible under the control of intelligence and will; and mere blind conservatism is nothing else than the action of unintelligent habit in politics. But it is only the law of habit that makes the formation of character possible, whether in an individual or in a community; and therefore what we have to do with the habitual forces is not to destroy them (for this, were it possible, would be mental suicide), but to keep them under control, so as to be capable of modification at the command of intelligence. This is true alike of the individual and of society. Politicians have been divided ever since political progress began, and will continue to be so until it has ceased, into two parties, or schools, which have borne various names at various times and places, but are known to us as those of Conservatism and Liberalism. It is felt by all that these names indicate an important and profound distinction, and it is felt by all who are anything more than mere partisans that this distinction does not coincide with the distinction of truth and falsehood, or with that of good and evil. The basis of Conservatism is in the permanence of habit: the basis of Liberalism is in the possibility of habit being controlled and modified by intelligence.

Conservatism and Liberalism.

The dominance of intelligence over unintelligent habit is probably imperfect in even the wisest individual men, and among nations it is well if it exists at all. Entire races,

[1] The relation of written to unwritten law appears to have been somewhat different in the ancient republics from what it is in England. The Twelve Tables of early Rome, and other ancient codes, according to Mr. Maine (Ancient Law, chap. i.), were not *additions* to the customary laws already in force, but only written *expositions* of them. Their usefulness consisted in their publicity: for there is reason to believe that, previous to their publication, the ruling aristocracies were the exclusive guardians of the legal traditions, and abused the power due to that function.

as for instance those of India, appear to regard the change of a custom or a law as impossible. To this blind conservatism is due the fact, which is illustrated in every page of history, that institutions have a tendency to outlive their usefulness. The best instance of this is probably the Papacy, which in the early Middle Ages was no doubt a beneficial institution, but has been a noxious one ever since the time of Innocent III.

Institutions outlive their usefulness.

CHAPTER XLI.

NATURAL SELECTION IN HISTORY.

IN the preceding chapter I have spoken of the application of the laws of habit and variation to the facts of history. In this chapter I shall speak of the application of the law of Natural Selection to the same.

Production of new types of character in colonization.

I shall first speak of the physical action of natural selection, in producing new types of mankind by the process of colonizing new countries. I mean colonization as it is effected now, by the voluntary emigration of individuals and of families; not, as it took place in prehistoric and early historic times, by the migration of whole tribes together.

Average difference of emigrants from the parent stock.

In the first place, it is the most restless, ambitious, and energetic that emigrate; this characteristic, like all others, tends to become hereditary; and thus, from the very first, a difference of average character is established between the emigrant population and the parent stock. I think it is certain that this cause has much to do with that peculiarity in the character of our North American and Australian kinsmen which is sometimes called energy and sometimes restlessness.

Direct effect of new circumstances.

Natural selection by climate of a race suited thereto,

In the second place, the different physical and social circumstances of the new country from those of the old will tend in various ways to modify character, and these modifications will also tend to be inherited.

Lastly, there will be some individuals and families among the emigrating population to whom the climate of their new country is congenial, and others to whom it is comparatively unhealthy: the former will have the greatest chance of surviving and of leaving descendants, while the latter die or abandon the country, in either case leaving few or

no children; so that, even without taking into account any direct action of the climate in adapting the people to itself, the action of natural selection will, in the course of generations, cause the colonial population to consist exclusively of persons who are suited to the climate in virtue of their physical constitution. Now, it is scarcely possible to doubt that with any such peculiarity of physical constitution some peculiarity of mental constitution will be correlated, though we know nothing of the laws of such correlations. And thus will a new national character be formed.[1] It is true that in this process there is no moral element, and no certainty, or even preponderant probability, of the new type of character being on the whole better than that of the parent race. But variety is ensured; and variety for its own sake appears to be a part of the purpose of nature.

and having a distinct character.

> "God fulfils Himself in many ways,
> Lest one good custom should corrupt the world."[2]

The process which I have now described is a purely physical one, and in no way peculiar to human history; indeed, there can be no doubt that new races of animals and of plants originate in this way, and have so originated in countless instances during the course of geological time. I now go on to speak of natural selection as a law of the moral world and a cause of historical progress.

This process is purely physical.

Natural selection is also true of the moral world.

The laws of habit and variation, as we have seen, are true of both the bodily and the mental functions; and, as I have endeavoured in the preceding chapter to show, those laws are applicable to the facts of human history. Now, human history is determined almost exclusively, not by the bodily but by the mental nature of man—not by that nature which he has in common with other animals,

History is determined by man's mental nature.

[1] According to Darwin (Origin of Species, p. 166), acclimatization is effected partly by the self-adaptation of the race to the new climate, and partly by natural, or in the case of cultivated plants by artificial, selection; and he avows himself unable to separate the respective effects of the two causes.

[2] Tennyson's "Morte d'Arthur." I have no doubt that Tennyson is perfectly aware of the thoroughly modern character of this sentiment, and of the anachronism of placing it in the mouth of a king of the heroic age.

but by that which is peculiar to himself. The reason of this is, that the mental nature, which distinguishes man from the lower animals, is also that in which consists the superiority of one man, and of one race of men, to another. This is a case of the law which I have mentioned in several places, that mental characters are more variable than bodily ones. But though it is a case of a biological law, it is none the less the ground of the truth that history is almost entirely not a physical but a mental process—or, as we say in more familiar language, that history is associated not with the physical but with the moral sciences. It is true that such physical causes as those which belong to geography and climate have had a most powerful influence on the course of history; but this does not make history a physical science: just as the facts of organic life cannot be understood without reference to the external conditions of life in the earth, the waters, and the air, and yet the laws of life are distinct from those of matter.

The law of natural selection implies that the life of every species is an incessant struggle for existence; and what causes advance in organization is, that victory in the struggle falls, on the whole, to the superior races. This is as true of man as of any other species; the whole history of man is a tale of struggle and conflict;[1] but what constitutes the peculiarity of human history is this, that among the lower races the conditions of success are almost exclusively physical, while with man they are almost exclusively moral. Among animals, victory, the preservation of life, and the chance of leaving offspring, depend on such qualities as fleetness, strength, keenness of sight or of scent, or, at the highest, on sagacity and cunning. The same may have been true of man in his earliest prehistoric condition, when as yet he was but little removed above the higher animals. But in any state of man which history records, and doubtless for long ages before the dawn of history, victory has been determined, on the whole, by

Victory in human conflicts depends on moral causes.

[1] What follows has been in a great degree suggested by a most able article, entitled "The Natural History of Morals," in the *North British Review* of December 1867.

quite a different set of qualities—not by physical but by moral superiority.

This will probably be assented to as self-evident; nevertheless, I think the conditions on which depend the success and predominance of races and nations are generally and systematically misunderstood. It is the most obvious, and, I suppose, the commonest notion, that victory belongs as a matter of course to the most courageous. Other things being equal, this no doubt is true. But it is very seldom that all other things are equal; and of all moral endowments, there is probably none in which men are more nearly equal than in what is significantly called "mere animal courage." The Duke of Wellington, a very competent judge, used to say that as a general rule all men are brave; and there is no doubt of the fierce valour of many Asiatic tribes; yet, with some partial exceptions in the history of the Mahomedan conquests, Asiatics, from the time of Miltiades till now, have always given way before Europeans. The causes of victory must reside, not in that lowest moral quality with respect to which men are comparatively on a level, but in those higher moral qualities with respect to which they differ indefinitely.

It does not depend chiefly on courage.

The most obvious and commonplace of all the conditions on which victory depends is the relative number on each side. In our times, this in no way depends on any moral superiority of the more numerous army, or of the nation that sends it forth. But it was not so at the beginning of civil society. We know that primitive tribes tend to break up into fragments, as in the case of the separation of the families of Abraham and Lot, and those of Jacob and Esau.[1] We have not, so far as I am aware, any direct evidence on the subject; but from what we know of human nature we may safely infer that the tendency to split up will be greater among a people of selfish and contentious temper, while those in whom the domestic virtues are more highly developed, and the civic virtues are coming

Superiority of power in a primitive state due to the domestic virtues.

[1] I believe the Book of Genesis, from Abraham forwards, to be mainly historical; ut whether it is so or not, the incidents referred to in the text are not the less characteristic of the period.

into existence, will be more likely to stay together, to live under the same government, and consequently to form a united and powerful tribe, able to overcome and conquer those tribes which are kept in a divided state by their deficiency in the domestic and civic virtues.

This cause of superiority can exist only so long as there is room for tribes to split up and separate. It will come to an end when the increase of population is sufficiently great to prevent them from spreading at will; when agriculture succeeds to a pastoral life, and tribes consolidate into nations. But when political communities are larger, and wars are waged on a larger scale, the conditions of success are even more distinctly moral. The first of these conditions are fidelity, and, what is intimately connected with this, the capacity for obedience. This subject is systematically misunderstood by Western Europeans, who often appear to think that self-assertion and untameableness of disposition are the best basis for the political virtues. It may be true that the greater is the difficulty of taming a race of men into civilization, the nobler is their character when they have been so tamed. This, I say, may be true, though I very much doubt it. But untameableness is simply the character of the savage, and freedom and the love of freedom are of no moral worth whatever unless they are based on loyalty and the capacity for obedience. Fidelity, loyalty, and the capacity for obedience are moral qualities of a very high order. It is these more than any others which make political and military combinations possible, and give political and military power.

The political virtues.

Thus the domestic virtues which keep a tribe together are those which conduce to power and to victory at the first dawning of civil life in the nomadic and patriarchal state; and the political virtues are those which conduce to power and to victory in a more advanced state of society. We may perhaps say with some approximation to accuracy that the former are characteristic of pastoral life, and the latter of agricultural. But there is a third kind of virtues which are characteristic of civic life, and are called from

them the civic virtues. It is not very easy to define in what civic virtue consists, but it is happily so well known among us that no definition is needed in order to make my meaning intelligible. It may perhaps be defined as the transference of loyalty from a superior to the community. It is shown in all history how the civic virtues form the best and surest bases of political and military power. The republics of Greece and Rome are the most conspicuous and the most familiar instances of this truth, though by no means the only ones. Holland and England in the modern world are equally good instances.

The civic virtues.

Thus virtue gives political and military power. In the strife of tribes, of races, and of nations—in the political as in the physical world—a process of natural selection goes on, of which the tendency is to give the victory to the best.[1]

Virtue confers power.

In the earliest periods it is probable that wars were always wars of extermination; and under those circumstances the effect of natural selection must have been simply that the inferior races perished and the superior ones survived. This process takes place even at the present day, where the inferior races are unable to adopt the ways of civilized life, though not now by means of massacre. It is going on before our eyes in Australia and New Zealand, and the comparatively benevolent disposition which civilized men have now acquired appears unable to arrest it. This is exactly the way in which natural selection acts as between contending races of animals—namely, by the destruction of the weakest. But at a later period, when men had become less brutal and savage, wars ceased to be wars of extermination, and became wars of conquest. And when one race is thus subjugated by another without being destroyed, a new set of conditions arises, to which there is nothing at all similar in the animal world. Among men as among animals, the progress of the entire species is ensured by the destruction of the inferior races. But when the inferior races are not destroyed, but only sub-

At first vanquished races were destroyed:

afterwards they were subjugated.

[1] On the subject of the tendency of virtue to confer political power, see a remarkable passage in Butler's Analogy of Religion, Part I. chapter iii. (pp. 71 and 72 in Bishop Fitzgerald's edition).

jugated, what is the effect of this on the entire species? This is not a question for merely historic or prehistoric research, but one of the deepest political interest and importance. The answer to it is, I think, on the whole satisfactory. Races which become dominant, whether through innate force of character or through favouring circumstances promoting their advancement in civilization, appear to have a power of raising the conquered races to their own level. The best instance of this probably is to be found in the results of the Roman conquest of Western Europe.

Political progress due to conquest.

But when nations, as distinguished from mere empires, are consolidated, it ceases to be possible for conquest to be any longer an agency of improvement; and thenceforward historical progress must be almost exclusively due to the arts of peace, industrial as well as political. But progress is still due to a process of natural selection, though natural selection is now applied, not to races of men, but to institutions and to ideas. In the peaceful strife of our modern times, however, as in the warlike strife of the ancient, the principle to which progress is due is still the same—namely, free competition and the victory and preservation of the best. It is only on this principle that freedom can be justified. The ever-repeated argument against freedom is, that the mass of mankind, when they have attained it, do not know what to do with it. This may be true; but, even if it were proved to be true, freedom would be none the less a means of good. It is a law of the organic world that many more seeds must be produced than can possibly mature their products; and it is a law of the human world that an immensely large proportion of effort shall be wasted. But it is only by permitting freedom of effort in all directions, with its unavoidable concomitant of waste, that any valuable results can be achieved. Where careers are open, many men will struggle into positions for which they are unfit. Where industry and commerce are uncontrolled, many disastrous blunders will be made by men in the exercise of their freedom. Where the expression of thought is free, much will be published that is

Ultimately, war ceases to be an agency of progress.

Peaceful progress due to competition and natural selection.

Justification of freedom.

foolish and mischievous. Hence it will always be possible to find arguments against freedom, which so far as they go are perfectly valid. The reason that modern political society is right in disregarding them is not that they are false, for they are not false; but that they are outweighed by immeasurably stronger arguments on the other side. Open careers may tempt men to waste their lives, but careers must, nevertheless, be open in order that the best men may be selected. Commercial freedom may tempt men into disastrous speculations, but commerce and industry must be free in order that it may be ascertained, by actual competition, in what way the industry of each district and each nation may be most profitably directed, and how commerce may be most successfully transacted. And freedom of thought—that is to say, freedom of discussion and publication—may lead to the dissemination of pernicious error, yet freedom of publication is necessary to the progress of knowledge, and free and fair discussion is the only means by which error can ever be killed. In a word, it is necessary that in the world of human society there should be full freedom (within the limits of morality and public safety) for the spontaneous variation of character, action, and thought, in order that the competition may select and preserve the best results, while the worthless ones perish.

In this chapter, as in the preceding, I have treated the questions under consideration in the barest outline. I have not endeavoured to exhaust the subject, but only to point out its existence.

CHAPTER XLII.

INDIVIDUAL AND SOCIAL ORGANIZATION.

IN the last two chapters I have shown how the principles of habit, variation, and natural selection apply to the historical sciences, as well as to the sciences of life and mind. In addition to these, I purpose in this chapter to speak of a special and very remarkable set of resemblances between the bodily life of an organism and the life of a society. The fundamental law of vital and of social organization is the same; namely, division of labour. The definition of organization is functional relation between parts; and, under this definition, a society where labour is divided—or, to speak more accurately, a society where employments are distributed—is not metaphorically but literally an organism. The expression, "physiological division of labour," has been borrowed by biology from political science, to signify what is called, in less suggestive language, the "specialization of functions." But to speak of the division of labour, whether in the individual or in the social organism, expresses only half the truth. The more unlike are the members one to another, the completer is the division of labour between them, and the completer is also their mutual dependence; and the greater is the power of the entire organism, by means of the combined action of its various unlike members, to achieve results which could not be achieved by any union of like parts. To use technical language: the greater is the differentiation, the completer is also the integration. This, which is

Division of labour in the organism and in society.

Society is an organism.

true of organic life, is equally true of social life. It is too familiar a truth to need insisting on, that the power, or efficiency, of a society depends on division of labour, and on ability to combine the several actions of the various members among which the labour is divided; and it is equally obvious to any one who has the slightest knowledge of comparative biology, that the efficiency of the nutritive, or motor, or sensory apparatus of an organism depends on the same conditions; namely on the distribution of functions between the several parts, and the consequent ability to combine the different actions of those parts.

The parallel between the individual and the social organism is, however, a much closer one than the foregoing remarks imply.

In the higher organisms—that is to say, in all animals except the Protozoa—there are two totally distinct sets of organs, namely the nutritive and the nervo-muscular. Similarly, the organization of society is twofold, industrial and political: the industrial organization of society is comparable to the nutritive organization of the animal, and the political organization of society is comparable to the nervo-muscular organization of the animal.

Nutritive and nervo-muscular organs.

Industrial and political organization.

There is also this resemblance, that the development of the community, like that of the individual organism, is from the simple to the complex.[1] In the simplest forms of human society there is no division of labour, except what is determined by the differences of age and sex. With social and political advance, the division of labour goes on constantly increasing. Moreover, the more highly organized among organisms grow to the largest size, and live the longest; those of lowest organization are mostly microscopic, and live for only a few days—in remarkable contrast with the whale, the elephant, and man. It is the same in societies; the communities of savages are very small, and last for but a few generations—unlike the kingdoms and republics of civilized men. I further believe

Social, like organic development, is from the simple to the complex.

The most highly organized are the largest and the longest lived.

[1] See the chapter on Organic Development (Chap. XI.).

that the highest organisms have been derived by descent, with modification, from the lowest; and that the most highly civilized societies have been developed out of savage ones by gradual advance.

Constant change of material.

Further: the material of the organism is constantly ceasing to live, and is cast off by excretion, while new matter is brought in and vitalized; so that the same organism, at successive periods, does not consist of the same matter. Just so, members of the community are constantly dying, while others are born; so that the same community, at successive periods, consists of different individuals.

Ground of the resemblance.

The parallel which I have drawn between the organic life of the individual and that of society is much too close to be accidental; it must be due to some common ground in the nature of both. This common ground, as I think, consists in these three truths:—

Life is in both a mode of activity.

1. Life, in both the individual organism and in society, is a mode of activity. Perfectly stagnant life would be a contradiction.

Habit.

2. The laws of habit are operative in both; and

Intelligence.

3. Habit and the other unintelligent forces are in both controlled by intelligence; to the action of which all advance in organization, whether individual or social, is due—organizing intelligence in the individual organism, mental intelligence in society. The mental intelligence to which social organization and social progress are due, acts for the most part with very little consciousness of the process which it effects; but organizing intelligence has no consciousness whatever.

Three differences between individual and social organization.

I have to remark, in conclusion, that there are three differences between individual and social organization, which ought to be clearly stated.

Social organization does not depend on structure.

In the individual organism, organization depends on structure; in other words, the relation of parts with respect to function depends on their relations of position and form. In societies this is not the case.

In the higher animals, the sentient life is concentrated

in the brain; and from this concentration or centralization of life, it follows that the parts exist for the whole. In societies, on the contrary, the whole exists for the parts.

In it the whole exists for the parts.

Societies, unlike individual organisms, have no reproductive function. The resemblance, in some shape, of the social organism to the individual is a very old speculation; and it has been often inferred therefrom that societies, like individuals, must be subject to decay and death. I think that, so far as the analogy is good for anything, it tells the other way; for if death is a law of individual life, so is birth; and births, in a normal state of things, compensate, and more than compensate, for deaths. But if death is a law of social life, there is no law of birth to compensate.

It has no reproductive function.

Are societies necessarily mortal? Argument for the negative.

NOTE.

HERBERT SPENCER ON THE SOCIAL ORGANISM.

It will be perceived that the ideas of the foregoing chapter are borrowed from Herbert Spencer's very ingenious and able essay on the same subject.[1] I think his leading idea is true and most valuable; but, not satisfied with pointing out the general resemblance between the principles of organization in the individual and the social organisms, he has attempted to draw a detailed parallel between particular organs and functions in the two, in a way which I think utterly untenable. This will be shown by stating the various parallelisms which he discovers, in a double tabular form. I need scarcely say that Herbert Spencer has not made them out in tabular form himself.

My objections on this subject to H. Spencer.

The working class.	The nutritive system.
The trading class.	The circulating system.
Commodities.	Blood.

[1] Republished in the second volume of his collected Essays.

Money.[1]	Red blood-corpuscles.
Roads, canals, and railways.	Blood-vessels.
Double lines of rail.	Double set of vessels (arteries and veins).
The governing class.	The nervo-muscular system.
Local and executive governments.	Ganglia, including the spinal cord.
Parliament.	The cerebral ganglia.
Telegraph wires.	Nerve fibres.
Telegraph wires used in working railway traffic.	Nerve fibres controlling the arteries.

I cannot see that I have done any injustice to Mr. Spencer in the foregoing summary of some of his special conclusions. I do not, however, mean to imply that they are nothing more than a mass of incongruities. His general parallel between the processes of development in the individual and in the social organism is most valuable. Mr. Spencer has laid himself the more open to such a criticism as mine by quoting a passage from Hobbes, in order to show its incongruities, which, as it appears to me, are of exactly the same kind as his own. I subjoin part of it, quoting the words exactly, but putting it into tabular form. Hobbes, I must mention, regards the "great leviathan called a commonwealth" as an artificial production, not a natural growth.

Hobbes on the same subject.

The *sovereignty* is	An artificial *soul*, as giving life and motion to the whole body.
The *magistrates* and other *officers* of judicature and execution	Artificial *joints*.

[1] "Silver and gold have to perform, in the organization of the state, the same function as the blood-corpuscles in the human organization. As these round discs, without themselves taking an immediate share in the nutritive process, are the medium, the essential condition of the change of matter, of the production of the heat and of the force by which the temperature of the body is kept up and the motions of the blood and all the juices are determined, so has gold become the medium of all activity in the life of the state." (Liebig, quoted by Spencer.)

The theory referred to in the above passage is, that the red blood-corpuscles are *carriers* of oxygen to the tissues, and of carbonic acid away from them; so that they are used in the process of nutrition without being consumed. Carpenter, however (Human Physiology, p. 198), refers to this theory as only a probable one.

Reward and *punishment*, by which, fastened to the seat of the sovereignty, every joint and member is moved to perform his duty, are . .	The *nerves*, that do the same in the body natural.
The *wealth* and *riches* of all the particular members are . .	The *strength*.
Salus populi, the *people's safety*	Its *business*.
Counsellors, by whom all things needful for it to know are suggested unto it, are . .	The *memory*.
Equity and *laws*	An artificial *reason* and *will*.
Concord	*Health*.
Sedition	*Sickness*.
Civil war	*Death*.

The incongruities of this speak for themselves.

CHAPTER XLIII.

THE CLASSIFICATION OF THE SCIENCES.

The present subject naturally comes at the end of the work.

THE appropriate place for a treatise on the classification and the mutual relation of the sciences is not at the beginning, but at the end of a work like the present. A classification of the sciences is not and cannot be a programme of work to be done, but only a *résumé* of work that has been done; in other words, it is impossible to classify the sciences until the sciences exist. It would have been impossible for Aristotle, or Bacon, or any other man, to lay down a chart of the course which scientific research and scientific thought would take when as yet science had scarcely begun its work. Such intellectual power as would have been needed in order to do so does not belong to man. To understand history is one of the highest attainments of man's intellect, but it does not belong to unassisted man to utter prophecy.

In this chapter it will be impossible for me to avoid repeating part of what has been said in the chapter on Organic Subordination.[1]

Any such classification must be imperfect.

It is to be observed at the outset that a paper classification of the sciences, like the paper classifications of zoology and botany, can be at the best only approximately correct. The divisions in both are in a great degree arbitrary, and the tabular form does not represent the real order of things with perfect accuracy. I think, however, that a much more complete and regular classification of the sciences is practicable than we could have expected.

[1] Chapter XIII.

When we seek for points of connexion between the sciences to serve as a basis for their classification, we come on this rather embarrassing fact, that there are subjects which belong to more than one science. I do not mean cases like those which occur in organic classification, where it is sometimes doubtful on which side of a boundary-line we ought to place some particular form. I mean cases where there is no doubt whatever that they belong equally to two sciences. Whether, for instance, does spectrum analysis belong to optics or to chemistry? Whether do the polarizing properties of crystals belong to optics or to crystallography? Whether do the facts of electro-chemical decomposition and the theory of the voltaic battery belong to chemistry or to electricity? The only possible answer is, that they belong equally to both.

Subjects belonging to more than one science.

Spectrum analysis: polarizing crystals: electro-chemistry.

This, then, is one kind of connexion between the sciences —namely, that one and the same subject may belong to more than one science. Another kind is when one science gives suggestions to another—such as, to mention the best instance that occurs to me, the instructive and valuable idea of the physiological division of labour which the science of human society has furnished to biology. A third kind of connexion is when one science furnishes materials to another, as in the case of biology furnishing to chemistry a variety of new substances, which constitute the subject of the branch of the latter science called organic chemistry. A fourth way is when one science becomes, in the literal sense, instrumental to another: I mean, when one science supplies another with instruments. Thus, optics has supplied astronomy with the telescope, thereby enabling it to explore the depths of the heavens; and has supplied biology with the microscope, thereby enabling it to examine the minutest structure of the tissues.

One science giving suggestions to another,

or furnishing materials to another,

or supplying instruments to another.

The telescope and the microscope.

It may perhaps be mentally added by the reader that mathematics has become instrumental to dynamics and astronomy, by supplying them with methods and formulæ. This is true, and a most important truth; but it is one of a different kind from the last mentioned. The connexion of optics with astronomy and with biology, through

Connexion of mathematics with dynamics.

the means of the telescope and the microscope, is only, as it were, accidental; that is to say, it does not depend on the nature of the sciences themselves. If this is not quite evident, it will become so on reflecting that it is conceivably quite possible, though unlikely, for a man to understand astronomy without understanding the theory of the telescope, or to be an accomplished physiologist without understanding the theory of the microscope. But the connexion of mathematics with dynamics and astronomy is of a different kind from this; for it would be impossible—impossible, I mean, in the sense of involving a contradiction—to understand dynamics and astronomy without understanding mathematics. The connexion of mathematics with dynamics and with astronomy (which is but a particular application of dynamics) is not in any sense accidental, but is grounded in the nature of dynamics. It would be impossible so much as to state the laws of dynamics without taking some of the truths of mathematics as known. Thus, to mention an elementary instance, it would be impossible to prove or to state the theorem of the parallelogram of forces without first knowing the geometrical properties of the parallelogram. Now, this kind of relation between sciences—namely, that in which the truths of one presuppose those of another—is the most fundamental of all relations, and is that whereon any rational classification or co-ordination of the sciences must be based.[1] That is to say, we have to arrange the sciences in such an order that the truths of each science presuppose and depend on the truths of that science which comes before it in the series, and are independent of all those which follow it. Thus dynamics depends on mathematics, and mathematics does not depend on dynamics or any other physical science.

The laws of dynamics imply those of mathematics.

This kind of relation is to be the basis of the classification,

which is to be a series.

In classifying all the sciences, however, we cannot perfectly attain to such an arrangement as this: we can only approximate to it. There is no possibility of so framing

Such a series is only approximately possible.

[1] I speak of this subject more briefly than I should otherwise do, in consequence of having gone into it in some detail in the chapter on Organic Subordination (Chap. XIII.).

an encyclopædia of the sciences that each separate science can be fully treated of without any anticipatory reference to those which are to follow it. For instance:—The chemical group of sciences, as I shall have to show, comes after the dynamical group, and is dependent thereon: electricity belongs on the whole to the dynamical group, yet the facts of electro-chemistry, as already remarked, belong as much to chemical as to electrical science, so that they cannot be explained or even stated without taking some of the facts of chemistry as known. The best arrangement of the sciences, however, is that in which the smallest number of such anticipatory references is needed; and we can approach much nearer to such an arrangement than could have been thought possible.

The order is from the simple and general to the complex and special.

The value of this arrangement is greatly increased by the fact that it places the simplest and most general subjects first, and the more complex and special ones after these; for the more complex and special subjects depend on the simpler and more general ones, but the simple and general do not depend on the complex and special. Thus the facts of biology are more complex than those of chemistry; and they are also more special; for all substances have chemical properties, but only some substances are vitalized, or capable of vitalization. It is necessary to observe that, in speaking of the simplicity and generality of any set of scientific facts, I speak of the subject-matter of the science only, and not of its processes. The processes of mathematics are more intricate than those of chemistry; but the subject-matter of mathematics is perfectly simple and absolutely general, consisting in the properties of space and time: while the subject-matters of chemistry are neither general nor simple; on the contrary, they are special, for every substance has its own peculiar properties; and they are so complex and varied that no complete enumeration is yet possible of the properties of any substance whatever.

Summary.

What I have said on the subject of the classification of the sciences may be summed up in this formula:—

The arrangement we are to aim at is that in which the more simple and general subjects come before the more complex and special, and in which each science depends on those which come before it in the series, but is independent of those which come after it. I think no intelligent man will question that, if it is practicable, such an arrangement is the right one. The question will be whether the sciences will fit into such an arrangement; and this is not a question for reasoning, but for trial. The only way of proving that such a classification can be made, is to make it.

No single series in nature.

I admit that there is no such thing, either in the classification of the sciences or anywhere else in nature, as a single linear series. All classification whatever is in groups of groups. But I think I shall show that the sciences do arrange themselves in a series of large groups, in which series the simpler and more general subjects come before the more complex and special ones, and each member of this series depends on those which go before it, but is independent of those which come after it.

First division, into logic and its applications.

Proceeding on these principles, the first and most fundamental division of the sciences is, as it appears to me, that into abstract logic on the one side, and the applications of logic on the other. Every possible science comes under one of these two heads: every science other than abstract logic consists in the application of logic to some particular class of subjects. In another way also logic is contrasted with the other sciences. All the other sciences are organa of discovery; that is to say, they make discoveries whereby we come to know what we did not know before. But logic is not an organon of discovery. It has no discoveries to make. When we master the science of logic, we do not learn anything that we were ignorant of before; we only become conscious of knowing what we previously knew unconsciously. The axioms that a contradiction cannot be true, that what is true of every one of a class is true of each one of the class, and that things which

Logic, unlike the other sciences, is not an organon.

co-exist with the same thing co-exist with each other,[1]—these have not been discovered by logicians:—logicians have not taught us these truths, but have only made us aware that we know them, and have always known them. Logic is exclusively occupied with determining the foundations of knowledge, and leaves the other sciences to build the superstructure; or, to use a different metaphor, logic works backward to the fundamental principles and assumptions of knowledge, and leaves the other sciences to work forward to inferences.[2]

Logical notation is not an instrument of reasoning.

It is for this reason—namely, because logic is not an organon of knowledge—that no logical notation can be of any use except for the purpose of illustrating the truths of logic itself. The notations of arithmetic and algebra are instruments of vast utility and power, but no notation of logic can be of the slightest use as an instrument of reasoning; though it may be—and, I think, in Professor Boole's hands[3] has been—of great use in showing the laws of reasoning.[4]

Logic is, on every ground, to be regarded as the first of the sciences. I do not mean the first in the sense of the

[1] The first of these three axioms is that which is called, in the language of technical logic, the principle of identity and contradiction; the second is the *dictum de omni et nullo*, on which the syllogism is based; the third is that which Mr. Mill places at the foundation of his logic.

[2] Questions however arise in many, perhaps in all sciences, which, like those of logic, have to do, not with extending knowledge, but with settling its basis. No one will question the great service done to science by Euclid in stating the postulates and axioms as he has done; and yet this work did not extend our knowledge: but it is always desirable, not only to extend knowledge as much as possible, but to settle its foundations;—not only to infer as much as possible, but to infer it from the smallest possible number of primary principles.

[3] See Boole's Laws of Thought.

[4] In the chapter on Mental Intelligence (Chap. XXXIX.), and in the present, I have throughout spoken of the laws of logic as being laws of the universe, and being laws of thought only because they are laws of the universe. Consequently, I altogether differ with those who would class logic as a branch of psychology; I think it would be as rational to call mathematics a branch of psychology because space and time are forms of thought, as to call logic a branch thereof because the laws of logic are laws of thought.

most important; I only mean that logic is the *initial* science—that which commences the series. Its subject-matter is perfectly simple, and it is absolutely universal in its generality; for no inference can be made on any subject whatever without involving the principles of logic: and the principles of logic do not depend on those of any other science, but the principles of all the other sciences depend on those of logic.

We now leave the subject of abstract logic, and proceed to the sciences which consist in applications of logic. Here the first and most important division of subject-matter is into the abstractions of space and time on the one side, and on the other all those things which exist in space and act in time—that is to say, all existing things whatever which are known to us. The science of the properties of space and time is mathematics; the sciences of the properties of existing things may be called the physical sciences; though it must be understood that these include psychology and those sciences which depend on psychology, such as the sciences of language and of history. On every ground, mathematics comes in our series before the physical sciences. The subject-matter of mathematical science is the properties of time and space, and time and space are perfectly simple and absolutely universal; while matter, which is the primary subject of physical science, is not simple in its properties, for they are so various that no one knows them all: nor is it universal in its extent, for only part of space is occupied by matter. And, as already remarked, the truths of a large part of the physical sciences, including especially all branches of abstract and applied dynamics, presuppose those of mathematics, while the truths of mathematics do not presuppose any physical truths.

Mathematical and physical sciences.

Mathematics comes before physics.

The three mathematical sciences are algebra, or the science of abstract quantity; arithmetic, or the science of number; and geometry, or the science of extension and form.

Algebra, arithmetic, and geometry.

We now go on to the physical sciences, or those

Logic is the initial science.

involving real existence; and here the first distinction is into the sciences of matter and those of life—or, to speak with more precision, into the sciences of the properties of unvitalized matter and the sciences whereof the subjects involve life. It is obvious that the sciences of life in our series come after those of matter, both because the facts of life are more complex and less general than those of matter, and because the laws of life presuppose those of matter. The sciences of matter, again, are divided into the dynamical group and the chemical—dynamics being the science of force and energy, and chemistry being the science of the transformations of matter. At the head of the dynamical group stands abstract or general dynamics, which consists of the theory of force and energy in so far as it is applicable to all cases whatever; and after this the secondary dynamical sciences (to use Dr. Whewell's expression) of sound, radiance, heat, electricity, and magnetism, each of which consists in a special set of applications of dynamical theory.

Sciences of matter and of life.

Those of matter come first.

Dynamical and chemical sciences.

General and secondary dynamical sciences.

The dynamical sciences come in our series before the chemical. This is partly because their subject is simpler. Energy is *one*, though capable of appearing under various forms, of which the principal are motion, heat, electricity, and radiance. Matter is also capable of assuming various forms, solid, liquid, and gaseous; and moreover it is not *one*, like energy, but consists of many distinct elements, which are not capable of mutual transformation. And besides, though matter and energy are functions one of the other, yet, as every one is aware who is at all conversant with this class of subjects, there are far more dynamical facts presupposed in chemical science than chemical facts presupposed in the dynamical sciences.

The dynamical come before the chemical.

The chemical group of sciences may be enumerated as molecular physics, chemistry, and crystallography. The names of the two latter need no explanation. Molecular physics has till now been usually regarded as a part of chemistry, and has been treated of in the introductory chapters of works on that subject; but I think it is now time to raise it to the rank of a distinct science. It may

Molecular physics, chemistry, and crystallography.

Molecular physics defined.

be defined as the science of the various states of molecular aggregation: it includes the theory of the gaseous or vaporous, the liquid, and the solid states of substances, and consequently of evaporation and freezing; of cohesion and capillarity, of solution, of gaseous and liquid diffusion, of osmose, and of various other kindred subjects.

Crystallography.

In strictness of definition, crystallography is a branch of molecular physics, but the facts of crystallography are so distinct and so peculiar that it is much better to treat it as a separate science. It is sufficiently obvious that molecular physics comes before chemistry in the series, because the simplest facts of chemistry would be unintelligible without some knowledge of molecular physics—enough, at least, to understand what is meant by solution or evaporation. Crystallography comes after chemistry, because every crystalline species is a distinct substance having its own peculiar chemical constitution, which is equally characteristic of it with its "crystallographic elements;" and this, of course, can be learned only from chemistry; while it is possible to understand chemistry as the science of combinations and decompositions without reference to the facts of crystallization, which indeed are referred to in chemical writings only occasionally.

Two groups of the sciences of life.

First, those of the properties of organisms.

Morphology and physiology.

We now come to the sciences of life. These fall into two very well-marked groups. The subject of the first group consists in the properties of organisms considered merely as such: these properties belong partly to morphology, or the science of organic forms, of which science systematic natural history is a part; and partly to physiology, or the science of vital functions. These two, no doubt, are both parts of biology, and they run into each other; but they do not, I think, run into each other more than do chemistry and crystallography; indeed, crystallography is a morphological science, and its relation to chemistry may be compared with the relation of organic morphology to physiology. Physiology and morphology are so distinct that systematic natural history, which is in fact comparative morphology, is not necessarily nor generally cultivated by the same persons who cultivate

physiology. I have defined physiology as the science of vital functions. But the conscious or mental functions are so different from the unconscious or bodily ones, that it is convenient, and indeed necessary, to treat of the former apart; or, in other words, to treat psychology as a distinct science.

Psychology. Second group:

The second group of the sciences that involve life has for subject-matter the results of the activity of the mind of man in language, art, and society; and the æsthetic, moral, and economical laws under which that activity is necessarily carried on. This group of sciences is much less advanced than the mathematical, physical, and mental sciences, and has not yet been systematized.[1]

not yet systematized.

In the foregoing brief review I have not aimed at anything more than an enumeration of the sciences in their order, with a statement of the subject-matter of each. It is now time to state the same in tabular form.

[1] See the preceding chapter.

Tabular statement

On reading over this enumeration, the most natural and probably the first remark of the reader will be that it must be very incomplete, for it omits some of the most important of the sciences. It has no place for astronomy, meteorology, or geology. This is true: the foregoing series is not a complete enumeration; it needs to be supplemented by another series, containing astronomy, meteorology, geology, and a few others. It is in the nature of things impossible to place all the sciences in a single series. Every one of the sciences enumerated in the foregoing tabular form has for its subject-matter a particular set of natural laws; and the tabular enumeration is an attempt at a classification of natural laws—a classification which probably will be found to admit of improvements in detail, though it is, I think, beyond doubt correct in principle. But such a science as astronomy or geology has for its subject-matter, not a particular set of laws, but a particular set of phenomena as actually found in nature. Now, it is evident that a science whereof the subject-matter is a particular set of laws, and one whereof the subject-matter is a particular set of phenomena, cannot properly be placed in the same series. This distinction would not be of any importance if each set of phenomena as occurring in nature were due to only a single set of laws: if, for instance, astronomy were exclusively an application of dynamical laws, meteorology of the laws of heat, and geology of the laws of chemistry and crystallization. But such is not the case; it is only approximately true of astronomy and meteorology, and is not true of geology at all. Astronomy is no doubt chiefly dynamical; but if we admit—as I think we must—the nebular theory as a legitimate branch of astronomy, it has to do also with the laws of heat and of the physical constitution of gases and vapours.[1] The most important facts of meteorology depend on the laws of heat, but some of them are electrical and some are optical. And the facts of geology do not depend

Position of astronomy, meteorology, and geology, in another series of sciences,

whereof the subjects are not laws but phenomena.

[1] It may be said that the study of the sun's atmosphere also belongs to astronomy, and yet it does not depend on dynamics. But it is better to regard this as a part of meteorology.

on any one set of natural laws, but on a vast complication of them—dynamical, thermal, chemical, and even vital; for we know that limestone and coal are organic products.

I propose to call them the cosmic sciences.

I propose to call the sciences now under consideration the cosmic sciences, in opposition to those enumerated above, which are abstract ones. The subject-matter of an abstract science is a particular group of laws, under whatever conditions or on whatever scale they may act: thus the motions of a star, the swinging of a pendulum, and the rotations of a gyroscope, all belong equally to dynamics. The subject-matter of a cosmic science, on the contrary, is a particular group of phenomena which may have no connexion except that they are found together: thus geology includes alike the theory of volcanoes, which (in my opinion at least, and I believe I am on the side of the best authorities) is entirely to be referred to the laws of force and heat, and the theory of the formation of coral islands, which is a vital process, though controlled by physical agencies.

Parallelism of the abstract and the cosmic sciences.

But, though the series of the abstract sciences and that of the cosmic sciences are not coincident, there is a kind of approximate parallelism between them. We have seen that the series of the abstract sciences begins with the simplest and most general laws, and goes on to the more complex and special ones. The series of the cosmic sciences, in like manner, begins with the simplest and vastest phenomena, and goes on to the more complex and less vast ones. The parallelism between the two series rests on the fact—which, as now expressed, is almost an identical proposition—that the most general laws, which are also the simplest, are those which act on the widest scale; so that there is a series of phenomena from the widest to the minutest, parallel to the series of laws from the most general to the most special. The simplest and most general of the *laws* of nature are those of dynamics; the simplest and vastest of the *phenomena* of nature are those of the celestial motions, which altogether depend on dynamical laws. All other phenomena are almost infinitely

Its ground.

Gradation of phenomena from the vastest to the smallest.

smaller than these; for the subject-matters of the twin sciences of meteorology and geology are not only special to each planet, but are confined to the surface of the planet: the domain of meteorology is confined to a few miles of height above the surface, and that of geology to about as many of depth below. And the phenomena of the distribution of life, again, are for the most part incomparably smaller than these: the largest trees are of insignificant size in comparison with the mountain; coral-reefs are the only products of life that attain to geographical importance, and they are small in comparison with continents. The laws of the distribution of living species on the surface of the earth are united with palæontology, or the science of the fossil remains of extinct forms of life. The subject of the distribution of living species may be called geographical biology, and palæontology may be called geological biology; but these form the subject of a single science: the laws which determine the distribution of species in the present cannot be separated from those which have determined the distribution and the succession of species in the past.

Astronomy.

We have seen that, in the order of the vastness and the simplicity of the phenomena, astronomy comes first among the cosmic sciences. Next to astronomy are those which treat of phenomena whereof the magnitude is such as to embrace an entire planet. There are three sciences which treat of phenomena of this order of magnitude. First, the theory of the force of terrestrial magnetism, its distribution, and its fluctuations;—this is not identical with the abstract laws of magnetism, but is an application thereof, just as astronomy is an application of the abstract laws of dynamics. Second, meteorology, or the theory of atmospheric changes and of the laws of climate; —this science chiefly consists of applications of the laws of heat and electricity to a great variety of circumstances, though it has a branch which stands in the same relation to the laws of radiance, and treats of such optical phenomena as rainbows and halos. Third, oceano-

Terrestrial magnetism.

Meteorology.

Oceanography. graphy,[1] or the science which treats of the tides, the currents, and other phenomena of the ocean;—except the tides, these almost exclusively depend on the winds and on temperatures, so that oceanography can scarcely be separated from the theory of climate.[2] Next in the order of vastness and simplicity come the sciences of those phenomena which are less extensive than the entire surface of a planet: these are geography, or the determination of the outlines of coasts, the courses of rivers, and the heights of mountains; and physical geology, or the science which treats of the constitution of the crust of the earth, and the causes to which that constitution is due. The facts of geology, as I have already remarked, cannot be referred to any single set of laws. Next in the order of the magnitude and generality of the phenomena comes mineralogy, or the science of the molecular structure and chemical composition of the rocks: it is, in fact, the molecular, chemical, and crystallographic branch of geology, and is related to physical geology much in the same way that molecular and chemical physics are related to general dynamics. And last of all, for the special and limited character of its phenomena, is palæontology, with the laws of the distribution of living species: the facts of this science in a great degree depend on those of biology, though, as I have shown in the chapter on Distribution,[3] this dependence is much less rigid than might have been expected.

Geography.

Geology.

Mineralogy.

Palæontology, and the distribution of species.

There is thus a kind of rough approximate parallelism between the two series of sciences, the abstract and the cosmic. Of course there is no cosmic science in any way corresponding to logic and mathematics. But astronomy pretty accurately corresponds to dynamics; terrestrial magnetism corresponds with perfect accuracy to the

Correspondences between the two series.

[1] Or what Maury calls the "physical geography of the sea." The absurdity of the expression "*geography* of the *sea*" may be best shown by translating it into German, in which language it would be "*Erd*-beschreibung des *Meeres*."

[2] The general theory of the tides belongs to astronomy, but those more special tidal phenomena which cannot be deduced from the general theory, but must be ascertained by observation, cannot be called astronomical.

[3] Chapter XVIII.

abstract theory of magnetism; meteorology and oceanography nearly correspond to the sciences of heat, electricity, and light—though the tides, which belong to oceanography, are purely dynamic phenomena. Geology does not correspond to any abstract science in particular, but mineralogy corresponds to the chemical group of sciences, and palæontology, with the laws of the distribution of species, to biology.

We may now enumerate the cosmic sciences in the following tabular form:—

Tabular enumeration of the cosmic sciences.

Astronomy.
Terrestrial magnetism.
Meteorology, with the theory of climate.
Oceanography.
Geography.
Geology.
Mineralogy, or chemical geology.
Palæontology, with the laws of the distribution of living species.

As I have said of the tabular enumeration of the abstract sciences, this enumeration also may probably admit of improvements in detail; but if the principle of the series is right, of which I think there can be no doubt, the details are of but little importance.

Imaginary case of a being coming near the universe: the order in which he would see its phenomena.

The order in which cosmic phenomena have been enumerated in the foregoing list of the cosmical sciences is that in which they would be witnessed by a being with powers of perception like our own, if it were to come towards our world from the regions of infinite space. At first it would see suns and planets as mere moving points of light, and could distinguish nothing about them except their magnitudes and their motions. Coming nearer, it would discern the phenomena on their surfaces; the spots on the sun and the peculiar currents of his atmosphere, and the clouds and winds and other phenomena of the atmosphere of the earth, with the ocean and its currents; and if it were possessed of our means of observation, it would perceive the magnetic properties of the earth, and

doubtless also of the sun and all the planets. Next in the order of descending magnitude, it would see the outlines and forms of coasts, of rivers, of lakes, of mountains, and all that forms the subject-matter of geography; and on coming a little nearer, it would see glaciers among some of the mountains, and volcanoes among others: it would see differences not only of form but of structure and composition between the masses that form the crust of the earth, and all the things which constitute the subject-matter of geology. And last of all, supposing this imaginary being to have microscopic powers as well as telescopic, it would see those facts which constitute the subject-matter of mineralogy and of palæontology, and the geographical distribution of life. At every step it would see less general and more complex phenomena.

Chain of laws; each link presupposing that which comes before it.

As we have seen, there is a chain of laws in nature, each link presupposing that which comes before it. The laws of life presuppose the special laws of matter, especially those of chemistry and heat; the special laws of matter presuppose the laws of general dynamics; and the laws of general dynamics presuppose those of mathematics, which are based on the properties of space and time. In the actual distribution of things, which constitutes the subject-matter of the cosmic sciences, there is a set of parallel relations to these. It is a necessary condition of life, that living beings should be surrounded with vast masses of unorganized matter in earth, water, and air. The air, the waters, and the surface of the earth are the seat of that play of forces which, with their results, constitute the subject-matter of meteorology and geology with their allied sciences: but these forces have no action except on the surfaces of the planets; their central masses are inert. And the planets and stars themselves are but insignificant in magnitude when compared with the vast empty spaces in which they move. To state the foregoing in fewer words:—Living beings are but insignificant in mass when compared with the masses of unorganized matter that surround them. Those masses of matter on the surface of our planet whereof the

Parallel to this in the arrangement of things.

Living beings are small in proportion to matter.

changes are seen in the facts of meteorology and geology, are insignificant in mass when compared with the vast, inert, unchanging central masses of the planets. And the planets and suns are but insignificant in magnitude when compared with the vacant celestial spaces around. All these are cases of the general law, that the simplest properties and laws are in force over the widest spaces, and on the largest scale. The properties of space are simpler than those of matter: the dynamical properties of matter, which alone act in causing the celestial motions, are simpler than its thermal, electric, magnetic, and chemical properties; and these, again, are simpler than the characteristic properties of living beings.

Matter is small in proportion to space.

The widest laws are the simplest, and act through the longest time.

The same relation of laws to each other holds good in time as in space. The simplest laws are the most uniform and the most general in their action, not only in space but also in time. The only truths, in any science, which we are safe in pronouncing to be absolutely unchangeable by any agency whatever, are the simplest and most fundamental of all truths, namely, those of logic. It is not possible even to Omnipotence to make a contradiction true. The properties of space and time, on the contrary, may be capable of change by the Divine will;—I do not assert that they are so; I only say we cannot assert that they are not;—and if it is so, of course the laws of mathematics may be changed with them.[1] Space and

The only certainly unalterable truths are those of logic.

[1] I do not mean that it is within the power of Omnipotence to make a mathematical absurdity true; for this would be to make a contradiction true. Omnipotence could not make two right lines enclose an area: that is to say, could not make two right lines *as we understand right lines*, enclose an area *as we understand an area;* for this would be to make either a right line or an area, or both, be what they are, and yet different: which would be a contradiction. But it is to me credible that Omnipotence might, without any contradiction being involved, have made the properties of space and time different from what they are. And I see no absurdity in thinking that the number of dimensions in space may be not three, but infinite: only that the universe to which we belong is capable of motion in but three of the dimensions; so that we have experience of but three, and cannot form a conception of any more. See the chapter on Perception (Chap. XXXVI.).

Time and space were before matter.

time, again, are conceived by us as being before matter and force came into existence: and this is actually true, if the universe had a beginning in time; which I regard as proved.[1]

Gravitation is the only constantly acting force.

Among forces also, gravitation, which is the simplest, is the only one that is always in action; the molecular and chemical forces act only under favourable circumstances, but gravitation never ceases to act; and it was also the first force to work in the primeval nebula.[2]

Life and mind are the latest products.

Finally, the most complex and special of all modes of activity, namely life, was of later origin than matter; and among the vital functions, mind was of later origin than unconscious life.

Thus, in both space and time, the most complex properties are the least widely distributed, and the least constantly in action. Now, as the highest results are the results of the most complex properties and forces, it follows from the necessity of the case that the highest natural products are comparatively small in quantity; and this we have seen to be the fact; life being a late and comparatively scanty product of nature, and mind a later and scantier product still.

The highest products are the least in quantity,

Thus nature may be compared to a tree, "expanding from the whole into the parts," to quote Schiller's expression; constantly branching out into greater multiplicity, complexity, and variety.

> "All nature widens upward. Evermore
> The simpler essence lower lies.
> More complex is more perfect, owning more
> Discourse, more widely wise."[3]

and the last in time.

And, as in the most beautiful trees the flowers come at the completion of the development of the plant, and are less abundant than the leaves, though of higher organization: so in the universe, the highest products come at the end of long ages of preparation for them, and are then less abundant than the lower products.

[1] See the chapter on the Motive Powers of the Universe (Chap. VI.).

[2] See Chapter VI.

[3] Tennyson's Palace of Art.

Harmony of the mind of man with nature.

It is one of the many remarkable harmonies between the mind of man and the universe of which it is the noblest product, that this distribution of the products of nature, both in space and in time, is that which appears beautiful to the artistic sense. It is a maxim in art that the highest beauty should be introduced in relatively small quantity: thus, in architecture, which is perhaps the best instance, such parts as cornices and capitals, which are at once small and conspicuous, can scarcely be too richly ornamented; but the effect would be very bad if the ornament which suits a cornice were spread over a wall, or if that which suits a capital were continued down the shaft of the column. In all art whatever, the effect of an equal distribution of beauty over every part is not good. In all art whatever, any part of a composition which rises above the general level of the whole in dignity or beauty will add dignity or beauty to the whole, provided that it is properly placed; while if any part sinks below the general level, it lowers the character of the whole. These principles are applicable alike to those arts which address themselves to the eye, and those which address themselves to the ear. But in the latter—that is to say in poetry and music, in which the parts of a composition are not simultaneous but successive—this further maxim is to be observed, that the highest beauty not only ought to be small in quantity, but ought to come last; and every previous part of the composition ought to lead up to it. In thus arranging his work, the artist, without knowing it, follows the example of nature, which, as I have already said, produces the highest results at the end of long ages of slow preparation, and then in comparatively small quantity.

Artistic rule of highest beauty in least quantity, and, in poetry an music, at the end.

Not all knowledge is included in the sciences enumerated in this chapter.

If it is asked whether I believe that all things which are capable of being known are capable of being included in the two tabular series that I have drawn out in this chapter, I reply that I have no such notion. In this work I have confined myself so far as possible to what is called positive science; that is to say, science having its data in

the facts of observation, or at least in facts external to the mind. Even in psychology I have endeavoured, so far as possible, to keep clear of metaphysical questions and metaphysical methods. But this is not from any belief that metaphysics are either impossible or worthless. On the contrary, I believe both in metaphysics and in theology as firmly as I believe in positive science; it is not from unbelief or indifference that I have said so little about them in this work; it is rather from a conviction of their transcendent importance that I have kept for a future work the subject of their relation to positive science.[1]

I believe in metaphysics and theology.

There is also a very large portion of human knowledge which never can become scientific. Common sense is right in opposing literature and history to science. The essential matter in science is for knowledge to be reasoned and formularized, and a fact that will not fit into any formula simply stands over until the right formula is found. But in literature and history, the essential matter is the display of human character; and this fascinates and instructs us most when it defies all formulæ most completely. It is true—at least I believe so—that such a thing is possible as a science of history, and a most important science it is. But, at the most, it can never be anything more than a science of general tendencies in history; and between understanding these and really knowing history, there is exactly the same kind of difference that there is between understanding psychology as a science and understanding human nature. It is true as a general tendency that distant and prosperous colonies will probably become independent, but it is not the less desirable to understand the character and the life of Washington. It is true that nations tend to become politically consolidated, but it is not the less desirable to understand the character and the life of Cavour.

Opposition of literature and history to science.

Nature of historical science.

[1] See Preface.

NOTE.

COMTE AND HUMBOLDT ON THE CLASSIFICATION OF THE SCIENCES.

My obligations to Comte.

It will be perceived that the idea of the series of the abstract sciences, which I have drawn out in some detail in the foregoing chapter, is taken from Comte's "Positive Philosophy." Comte's series of the sciences is the following :—

His series of the sciences.

Mathematics, including dynamics.
Astronomy.
Physics.
Chemistry.
Biology.
Sociology, or Historical and Political Science.

Where my series differs from his.

My series is the same as this in principle, but differs in some points of detail. The differences may be very briefly enumerated, and are as follow :—

Position of dynamics:

I regard general dynamics as a branch, not of mathematics, but of physics ; meaning by physics the whole of the dynamical group of sciences.

of astronomy.

I do not place astronomy in the series of the abstract sciences at all, but in the parallel series of the cosmic sciences ; because astronomy, or the science of the celestial bodies, has not to do with a special set of *laws*, but a special set of *phenomena*. The force of gravitation, and the laws of motion, are exemplified in terrestrial motions as well as in celestial ones: the law of the motion of a cannon-ball, or of a stone thrown from the hand, for instance, is of the same kind with the law of a planet's motion. It is the error of *cross division* to classify the sciences partly according to the *nature* of their subject-matter, as in separating biology from physics and chemistry, and partly according to its *locality*, as in separating astronomy from terrestrial physics.

With respect to the place of chemistry and biology, my arrangement agrees with Comte's. Sociology, by which barbarous compound Comte means the science of history and politics, occupies the place in his series which I have assigned to a group of sciences not yet systematized. Historical science is one of

Science of language omitted by Comte.

this group, and the science of language is another. It is a great fault in Comte's series of the sciences, though only a fault of detail and not of principle, that he has left no possible place for the science of language.

My obligations to Humboldt.

My idea of the series of the cosmic sciences is taken from the first volume of Humboldt's "Cosmos," though Humboldt has not given it in a tabular shape, nor has he formally separated the subject of his work into its natural divisions. Humboldt's arrangement of his subject appears to have been thought out without any suggestion whatever derived from Comte. The parallelism between the series of abstract sciences as arranged by Comte, and the series of cosmic sciences as arranged by Humboldt, has not, so far as I am aware, been pointed out before.

CHAPTER XLIV.

REMARKS ON THE HISTORY OF SCIENCE.

ACCORDING to the principles laid down in the preceding chapter, the logical order of arrangement for the sciences is an arrangement in series, beginning with those whereof the subject-matter is most simple and general, and going on to those whereof it is more complex and special.

Agreement of the historical order of the evolution of the sciences with their logical order.

This, which is the logical order, is also in a great degree the historical order. Those sciences whereof the subject-matter is simple and general have for the most part come into existence as sciences earlier than those whereof the subject-matter is more complex and special. This is what we might have expected, and for two reasons. In the first place, the simplest subject-matter is the easiest to master; and in the second place, it is necessary to understand the more general laws before the more special ones can be understood. Thus, mathematics is necessary as the key to dynamics; general dynamics as the key to the laws of heat and electricity; the sciences of heat and electricity as the key to chemistry; and chemistry as the key to physiology. In a word, the most general truths were the first to be discovered. As in painting a picture, the artist first sketches the outline, and completion does not mean covering more canvas, but filling in the outline with more detail; so in the history of science the widest truths have been laid down first; and progress consists in the discovery of a constantly increasing number of more special truths, and in the ascertainment of their relation to the general ones. Thus, for instance, the most important

Illustration from painting a picture.

single step which has probably been made in the progress of science since the time of Newton consists in the discovery of the laws of heat, and their establishment as a particular case of the more general theory of force.

But, like all mere illustrations, this comparison of scientific progress to the progress of a picture towards completion is only partially applicable; and it is not rigidly true, but only an approximation to the truth, to say that the historical order in which the sciences have been successively evolved corresponds to the logical order of their arrangement, beginning with the most general and simple subjects, and going on to the more special and complex. The logical order of the sciences throws a real and valuable light on their history. But it is, after all, only a logical formula; a logical formula will be always misleading if it is mistaken for actual historical fact; and this formula only explains half the facts. It is true that the progress of science is from more general truths to more special ones; but it is also true that it consists, at the same time, in the discovery of special facts and in generalizing from them. Thus the progress of science is twofold, and in two directions at once; it is at once downward, or deductive, consisting in the application of known laws to new cases; and upward, or inductive, consisting in the discovery of new laws by a process of generalizing from facts.[1] These two processes of discovery, the deductive and the inductive, sometimes go on apart. In mathematics, all is deduction; in chemistry, all until now has been induction, except the deductive element which enters into the relations of chemistry with the laws of electricity and heat. But at other times induction and deduction cooperate, as in the instance just mentioned of the ascertainment of the theory of heat as a particular case of the general theory of force and energy. The laws of heat were ascertained inductively, by experiment, and by generalized inference from a variety of experiments; and the

The truth stated above is only approximate.

The progress of science is twofold, deductive and inductive.

Mathematics is deductive, chemistry mostly inductive:

the science of heat is both.

[1] See "The Genesis of Science," in vol. i. of Herbert Spencer's collected Essays.

laws of force were applied by deductive reasoning to explain the laws of heat.

It is, however, roughly and approximately true, that the order in which the sciences have been historically evolved corresponds to the logical order of their arrangement, beginning with simple and general laws and going on to more complex and special ones. But, in addition to what has been said in the last paragraph, this must be understood with two other important qualifications.

The logical relations of a science are not always obvious at first.

In the first place, though each science is logically based on that more simple and general science which comes before it in the series, yet this is not always, nor generally, apparent at the time when the study of the science is first begun. Most sciences have been begun independently, and without any reference in the minds of their founders to any other science. In most cases each science has been commenced, and has made considerable progress, before its students became aware of its relation with that science which comes next before it in the series, and on which it is logically based. This is not the case with dynamics: dynamics is unable to take a single step without the aid of mathematics. But it is true of the sciences of observation and experiment. Thus, chemistry is based on the dynamical group of sciences, especially on those of electricity and heat: but this did not prevent chemistry from making a beginning, and being in a tolerably forward state, before electro-chemistry and thermo-chemistry were thought of. In the same way, biology is based on chemistry; for such physiological laws as those of nutrition and of respiration involve chemical laws, and cannot be stated without presupposing them: and yet biology had made considerable progress before this relation was perceived. Were it not possible for a science to be thus begun independently, the progress of science would have been much slower than it actually has been. The fact is, however, that most sciences have been begun independently; and the perception of the true relation of each science to the rest, and of the right place of each in the scientific scale, has been, not an

A science may originate independently, and usually has done so.

original condition of its commencement, but a late result of its progress.

In the second place, it is only an approximation to the truth to say that the early development of a science depends on the simplicity and generality of its subject-matter. What really causes a science to be developed early is partly the accessibility of the facts which constitute its data, and partly the obviousness of its fundamental conceptions. This, I think, is as nearly true as a general statement of the kind can be. It is very interesting to observe that the early development of a science does not appear to be in any degree prevented by the elaborateness and intricacy of the reasoning processes which it requires. Thus, there is no other science in which the reasoning processes are so elaborate and intricate as in mathematics, and yet it was the first among the sciences, with the exception of logic, that attained to any high development: the reasons of this evidently are, that the facts which constitute its data are perfectly accessible, and its fundamental conceptions very obvious. This is especially true of the geometrical branch of mathematics. The data of algebra, like those of geometry, are perfectly accessible; but its fundamental conceptions are not so obvious as those of geometry, and consequently it was later in being developed. The fundamental conceptions of chemistry, on the contrary, are so obvious as to present no difficulty whatever; but its data are not very easy of access, because they do not lie open to observation, but have to be sought out by experiment: and the same remark applies to all the experimental sciences. It is sufficiently obvious, that if the other difficulties are equal, a science of observation will necessarily make earlier progress than one of experiment. This is not so much because experiment is laborious, as because in the infancy of a science there is hardly anything to guide it; it is a mere searching in the dark. It would have needed more than human ingenuity to devise, *à priori* and all at once, a set of experiments to discover the composition of water: while it is comparatively easy to examine the anatomy of a limb, or to

What the early origin of a science depends on.

Mathematics.

Geometry and algebra.

Chemistry.

Sciences of observation are easier than those of experiment.

compare and classify plants and animals of various kinds. Thus organic morphology, including anatomy and systematic natural history, attained to some considerable degree of progress at a comparatively early period in the history of science, because the more elementary of its fundamental conceptions present no difficulty, and the facts which constitute its data are open to observation.

Morphology.

The fact that mathematics was earlier developed than any physical science, is, when properly considered, a very interesting and significant fact. Science began with mathematics. It might have been expected that its beginning would be at some point nearer to human life and duty—that it would have begun at biology, or psychology, or politics, and not at mathematics, which of all possible studies is the remotest from human life. Socrates regarded it as a useless waste of time and thought to study external nature, while he knew so little about the nature of man; and Galileo's contemporaries might have plausibly said, "Why do you gaze on the stars, which are far off, while you know so little of the flowers which are under your feet?" Such objections were, so far as I can see, quite unanswerable in the infancy of science; they could not be refuted, and they were overcome only by the refusal of the scientific instinct to listen to them. But now we have learned more of the external world than we shall probably ever know of man, and we have learned more of the motions of the stars than we shall probably ever know of the growth of the flowers. Science, at its origin, was too remote from human life to be obviously useful, and would never have made any progress whatever if it had waited to justify its existence by its usefulness: its first progress was due to its own intrinsic intellectual interest.[1] And the same is still practically true, although the usefulness

Science began at the point most remote from human life, and was consequently deemed useless:

and still its moving power is not useful.

1 Chemistry is a partial exception: the search after the process for making gold appears to have done something for its progress. But the effect of this was probably very slight; and the great discoveries of Lavoisier and his contemporaries, which really founded the science of chemistry, were made without any such stimulus.

ness, but intellectual interest.

of science is now no longer doubted by any except the most ignorant: the motive power of scientific progress is still, as at the first, not its usefulness but its intellectual interest. Were science always engaged in the search after obvious and direct utilities, the highest discoveries would never be made, and the greatest utilities would in all probability be missed.

> "So 'twere to cramp its use, if I
> Should hook it to some useful end." [1]

The telegraph.

It was not in seeking for some rapid and certain means of telegraphing, that the properties of the electric current were discovered.

The remark, that the beginning of science was at the remotest point from human life, is true also in a somewhat different sense from that which has been insisted on above.

All inorganic science depends on measurements of space.

All science—all inorganic science, at least—depends on measurement; and all other measurements ultimately depend on the measurement of space. Now space is altogether external to the mind: we think in time and not in space;[2] yet the measurement of time depends on that of space, and not the converse; and geometry, which is the science of the properties of space, was the earliest of the sciences.

NOTE.

Measurement of linear spaces:

EQUAL linear spaces, or equal lines, are those which are capable of being brought alongside of each other so as to coincide. The measurement of superficial and of solid magnitudes, and all other measurements whatever, depend on this.[3]

[1] Tennyson's Day-dream.

[2] See the Chapter on the Relation of the Mind to Space and Time (Chap. XXXVII.).

[3] This remark is made in H. Spencer's First Principles.

Equal velocities are those which keep at the same distance when moving in the same direction on the same line or on parallel lines. of velocity:

Equal times are those in which equal velocities traverse equal spaces. of time:

Equal forces are those which produce equal velocities in equal times. Or (what is a corollary from this), equal forces are those which, when acting in opposite directions, neutralize each other. of force:

Equal resistances are those which neutralize equal forces. of resistance:

Equal quantities of energy are those which overcome equal resistances through equal spaces. of energy.

CHAPTER XLV.

REMARKS ON THE LOGIC OF THE SCIENCES.

AS we have seen in the preceding chapter, different methods of discovery belong to different sciences; thus, demonstration pre-eminently belongs to mathematics, and experiment to chemistry. Mathematical methods have not yet been successfully applied to chemistry, though perhaps it may some day be found possible to do so; but we may positively assert that they never can be applied to the science of life. Indeed it may be stated as a general truth, that the more special and complex are the facts which constitute the subject-matter of a science, the less susceptible is it of mathematical treatment. Thus, general dynamics is altogether a mathematical science; the secondary dynamical sciences (sound, radiance, heat, electricity, and magnetism) are so in great part; chemistry may perhaps become so; but the sciences that involve life can never by any possibility become mathematical.

The more special and complex is the subject of a science, the less is mathematics applicable to it.

This peculiarity of the sciences of life is connected with the truth that their facts, even when perfectly well ascertained, are not capable of being determined with the same kind of precision as those of the inorganic sciences. In chemistry, for instance, the proportions in which two substances combine are in many cases known with perfect numerical accuracy, and are in all cases capable of being so known. In biology, on the contrary, no such accurate determinations are possible: this is not because the quantitative relations are too difficult to determine; it is because they are variable,

In connexion with this, the facts of life are in some degree indefinite.

within moderate limits no doubt, but without any ascertainable law. Thus, in that branch of biology which is most nearly connected with chemistry, it is impossible to state the effect of medicines, or of poisons, with the same kind of accuracy to which we are accustomed in chemistry. We know that laudanum will produce sleep, and that strychnine will kill; but, even if the constitution of the patient is known, it is impossible to say how much laudanum will be sufficient to cause sleep, or how much strychnine will be sufficient to kill, with the same kind of precision with which we can say how much of an acid is required in order to saturate a given quantity of alkali. But the determinations of biological science, though thus inferior in precision to those of the inorganic sciences, are in no sense, and in no degree, inferior to them in certainty. The same is true, and even more eminently so, in the higher branches of biology. Thus, the law that all actions tend to become habitual, is as well established as it is possible for such a law to be; but it is impossible, in any case whatever, to say how many times an action must be repeated in order to make it habitual, or, again, for how long it must be discontinued in order to destroy the habit by disuse. In the sciences of society also, in morals and in politics, there are laws of general tendencies, but no quantitative laws; consequently there is *certainty without precision*. It is, for instance, as certain as anything can be, that the tendency of falsehood is injurious to human happiness; but it is never possible to tell how much injury any particular falsehood will do, or has done. The ethical bearing of this truth is very important, but it does not belong to the subject of this work.

This does not imply any uncertainty.

The same is true of morals.

Certainty without precision.

We may enumerate four fallacies on the subject of the relation of mathematics and of logic to the other sciences. They all, I believe, have their origin in the fact that mathematics and logic were the earliest sciences in the field; and they are relics of the time when those were almost the only sciences, and when Pascal wrote of "the geometrical spirit," meaning the scientific spirit. These four fallacies are as follow:—

Four fallacies, and their origin:

that logic is an organon of discovery:

1. The fallacy that logic is an organon of discovery. This was the error of the scholastic philosophy, and was that against which Bacon's whole philosophical career was employed in contending. It is now so completely discredited that I need not spend many words in refuting it. I have stated in a former chapter[1] what is now the universally received conclusion on this subject;—namely, that the function of logic, regarded as a science, is not to extend the structure of our knowledge, but to fix its foundations.

that mathematics is the type of science:

2. The fallacy that mathematics is the type of all science. Mathematics is altogether a deductive science; that is to say, it is a science of pure reasoning; and consequently it cannot possibly be the type of sciences of observation like anatomy and histology, or sciences of experiment like chemistry. Even if chemistry hereafter becomes in part a mathematical science, as the sciences of electricity and heat have done, yet, like them, it must always continue to be in part experimental, and in so far as it is experimental, it cannot be mathematical.

that clearness and intelligibleness are tests of truth:

3. The fallacy that simplicity and intelligibleness are tests of truth. This was formularized as an axiom by Descartes, who laid down as the foundation of his philosophy that what is conceivable with perfect clearness must be true. This was the error of a geometrician; for, in geometry, nothing can be clearly conceived unless it is true; and whatever is true must necessarily be clearly conceived as soon as it is fully understood. In physical science, on the contrary, truth is mere truth of fact, and error consequently involves no logical absurdity; and a conception may be clear and yet not true. But though it is not true that clearness is a test of truth, yet it is true that inability to attain to clearness is a proof of imperfect knowledge. Yet even this test must be applied with caution; for there are many subjects on which our knowledge must always be imperfect;—I do not mean merely limited in extent, but surrounded with a kind of haze of mystery: this is especially true of the mutual relation of the conscious and the unconscious life, and of all the facts

[1] The chapter on the Classification of the Sciences (Chap. XLIII.).

of unconscious intelligence. It is also true that self-contradiction is a proof of error: but this test also needs caution in its application; for it is always necessary, and often difficult, to determine whether a contradiction is real or only verbal.

that precision is the criterion of certainty.

4. Lastly, the fallacy that precision is the criterion of certainty. I have insisted above at some length on the important truth that certainty without precision or definiteness is characteristic of the facts of life. It is important clearly to conceive this distinction between certainty and precision, because a vague notion appears to be very common, that precision is the criterion of certainty, and that no truth can be perfectly certain unless it is capable of being stated with numerical accuracy; and consequently that the certainty which is attainable in the moral and political sciences is inferior in degree to that which is attainable in the mathematical and the physical ones. This notion is never, I think, stated as a formula; indeed, it would refute itself if it were; for were it true that no numerically indefinite proposition can be quite certain, it would follow that because no man knows how long he has to live, it is therefore not quite certain whether he is to die at all: a conclusion which it would be impossible to accept. But the notion of some necessary connexion between certainty and precision is, I think, implied in such expressions as "mathematical certainty" and "mathematical precision;" and in the belief, which is often avowed and oftener implied, that no general truths are attainable concerning the social relations of man; that historical and political science are consequently impossible, and that history is, and ever must be, a mass of mere facts, and politics a chaos of mere opinions. The prevalent unbelief in the possibility of historical and political science, however, though it allies itself with the lingering notion that determinations cannot be certain unless they are also precise, is chiefly due to the fact that the political group of sciences is still in a very immature state. But, as I have remarked in the introduction to this work,[1] the time

[1] Vol. I. p. 6.

Extension of the use of the word science.

is coming when the use of the word science in the sense of only mathematical and physical science will be extinct, or, if it survives, will survive merely as a relic of an extinct habit of thought. We have already begun familiarly to use such expressions as the science of language, the science of history, and the science of politics: a notion still survives that such a use of the word science is a somewhat inaccurate extension of the meaning of the word; but I believe that in another generation such expressions will come to be used with no more sense of inaccuracy or of paradox than we have when we speak of the science of chemistry or the science of astronomy.

Double method in science.

Induction and deduction must co-operate.

It is an important truth, that perfect scientific method consists in the co-operation of the inductive and deductive methods; and perfect scientific proof consists in the results of the two methods coinciding. Thus in astronomy the results of induction and of deduction, that is to say of observation and of calculation, coincide within very small limits of error; and the same is true of the sciences of sound, radiance, heat, electricity, and magnetism. None of these sciences could have attained to anything at all comparable to their present perfection without the use of this double method: in which the calculated results of theoretical deduction are checked and verified by the results obtained by induction from observation and experiment; while at the same time, by the converse process, the results obtained by induction from observation and experiment are checked and verified by the calculated results of theoretical deduction.[1] In language which is at once familiar and accurate, this is called the coincidence of the results of theory with those of observation. As was

Theory and observation.

[1] It is usual to call the experimental result the verification of the theoretical one. According to Comte, in physical science the results of theory are verified by observation or experiment; but in historical science the results are first generalized from observation, and then verified by theory (the theoretical data in this case consist, of course, in the general laws of human nature). This may be true, but it is not very important. The important and universal truth on the subject is, that the results of the theoretical and of the experimental methods each need to be verified by the other.

remarked by Paracelsus, before the time of Bacon, theory alone will lead to mere fantasy, and observation alone will lead to mere empiricism. The best instance of the powerlessness of observation alone is perhaps the present state of meteorology, or the science of the weather; in which we have a vast mass of observations, and yet, for want of knowing how to bring deductive theory to bear on them, we are almost as far as ever from knowing the laws and causes on which the changes of the weather depend. The powerlessness of theory alone is best shown by the utter failure of all attempts to account for the facts of human society and historical change by merely theoretical deduction from the laws of human nature.

Failure of each alone. Paracelsus. Meteorology.

It is of course impossible that historical science can ever become mathematical in form; nevertheless I think we are safe in asserting that the relation of theory to observation is the same in the historical sciences as in the mathematico-physical ones, such as astronomy and the science of heat. Certainty in the science of historical principles (of course I do not mean mere historical facts) is attained only when the laws generalized from the observed facts of history, and the laws theoretically deduced from the general tendencies of human nature, coincide so as to verify each other. As an instance of this—not perhaps the best instance that might be mentioned, but the most familiar—I will mention the conclusion which all unprejudiced men now accept, of the economical benefit of freedom of industry and exchange, or what is familiarly called free trade. This conclusion was first deduced by theory from some of the commonest facts of human nature, and has been amply verified by the experience of every state which has had the wisdom to adopt it.

Historical science: its method is the same as that of physical science. Free trade.

It may be thought that mathematics is an exception to the law of the necessity for verifying the results of the one method by those of the other;—it may be thought that the deductive results of pure or abstract mathematics need no verification. It is no doubt the fact that we take them as true without demanding verification; that is to say, when we are satisfied of the accuracy of a mathematical calcula-

In what sense mathematics needs verification.

tion, we are satisfied of the truth of the result, and do not need to test it by counting or measuring. But I think, though I do not wish to speak dogmatically on a question which rather belongs to metaphysics than to logic, that the reason why we do not demand verification for the results of mathematical reasoning is only that general experience assures us of their trustworthiness. But—to put a case which, though not possible, is quite conceivable—if the whole algebraic calculus had been invented before any part of it was applied to actual use, I do not think that a reasonable man would have been justified in feeling absolutely certain of the truth of its results until they had been tested, checked, and verified. But this is not because of anything uncertain or contingent in the nature of mathematical truth; it is only because of the limitation of our powers. This remark, however, applies to all the sciences alike; it is only the limitation of human powers that makes it necessary to verify the results of theoretic deduction by observation. We can imagine an intelligence similar in kind to ours, though very much more powerful, which should be able to calculate and predict all the special facts of nature by pure deduction from the primary laws of matter and of life, and this with such unerring certainty as to be independent of any verification by the observation of facts.

Conclusion.

I have in several places insisted on the truth, that the *universal* tendency of science is to establish unity of laws throughout nature; and I believe that in the present work I have done something to extend the domain of sound scientific ideas, by showing that Habit and Intelligence are both of them co-extensive with Life, with Mind, and with History. But it is obvious that there must be somewhere a limit to such generalizations as these: it is obvious that all the facts of nature can never be brought under a single law. It can never, for instance, be possible to refer the laws of chemical combinations to those of motion and gravitation; and, as I have argued at some length, it is equally impossible to deduce Intelligence from Habit, or from any unintelligent principle whatever.

APPENDIX.

APPENDIX.

As indicated in the title-page of this work, its principal purpose is to state what I believe to be the laws of Habit and the laws of Intelligence; and further, to show my reasons for believing that intelligence is a distinct principle, not capable of being resolved into habit or into any other unintelligent agency. In so far as this work is a controversial one at all, its purpose is to prove the independent and ultimate character of intelligence.

This question as to the ultimate character of intelligence, however, does not stand alone. It is the second of a series of three closely related questions, which may be thus stated:— Three questions:

1. Is life a mere result of physical and chemical forces? or is it something transcending all chemistry, and having its origin directly in creative power? Is life an ultimate fact?

2. Are the organizing power which builds up the wondrous structures of the body, and the intelligence of the mind, mere results of habit, variation, and natural selection? or are they both due to a principle of intelligence which is not capable of being resolved into any unintelligent principle? Are organizing and mental intelligence ultimate facts?

3. Is the moral sense to be accounted for by the laws of the association of ideas—that is to say, of mental habit? or is it altogether peculiar, and incapable of being resolved into anything else? Is the moral sense an ultimate fact?

In this work I have answered all these questions in the same way: I have expressed my belief that life, intelligence, and the moral sense are each incapable of being resolved into anything lower than itself. I answer all in the affirmative.

With respect to the moral sense, I have briefly stated my conviction that although it is developed out of the love of pleasure and the fear of pain, yet it contains an element which Moral sense.

altogether transcends organic life and sensation.[1] A full discussion of the grounds of this belief, and of its results, would be out of place in this work; I intend to endeavour to do justice to the subject in a future one.

Intelligence.

With respect to organizing intelligence and mental intelligence, the most important chapters of this work consist of an attempt to prove that they are not capable of being resolved into any unintelligent agencies. It would be needless to recapitulate my reasonings on the subject here.

Life.

But with respect to life, I have somewhat more to say. In the chapter on the Chemistry of Life, I have stated my belief that "life, like matter and energy, had its origin in no secondary cause, but in the direct action of creative power;"[2] giving as my principal reason that no merely chemical force appears to be capable of vitalizing matter: matter can be vitalized, and living beings can be produced, only by beings which are already alive; and no science appears to be able to bring us to the origin of life, any more than to the origin of matter.

Since the first volume of this work has been printed, Professor Huxley has published the opposite opinion to mine, in an article "On the Physical Basis of Life."[3] In a question of this sort, I must request the reader not to permit Huxley's high authority to influence his conclusion, but to weigh my reasoning against his.

I quote Huxley's words, italicising some of them:—

Quotation from Huxley.

"When hydrogen and oxygen are mixed in a certain proportion, *and an electric spark is passed through* them, they disappear, and a quantity of water equal to the sum of their weights appears in their place. There is not the slightest parity between the passive and active powers of the water and those of the oxygen and hydrogen which have given rise to it. At 32° Fahr. and far below that temperature, oxygen and hydrogen are elastic gaseous bodies whose particles tend to rush away from one another with great force. Water at the same temperature is a strong though brittle solid, whose particles tend to cohere into definite geometrical shapes, and sometimes build up frosty imitations of the most complex forms of vegetable foliage. Nevertheless, we call these and many other strange phenomena the properties of the water; and we do not hesitate to believe

[1] See Chapter XXII. [2] Vol. I. p. 89.

[3] Fortnightly Review, February 1869.

that in some way or another they result from the properties of the component elements of the water. We do not assume that a something called 'aquosity' entered into and took possession of the oxide of hydrogen as soon as it was formed, and then guided the aqueous particles to their places in the facets of the crystal or amongst the leaflets of the hoar-frost. On the contrary, we live in the hope and in the faith that by the advance of molecular physics we shall by and by be able to see our way as clearly from the constituents of water to the properties of water as we are now able to deduce the operations of a watch from the form of its parts and the manner in which they are put together. Is the case in any way changed when carbonic acid, water, and ammonia disappear, and in their place, *under the influence of pre-existing living protoplasm*, an equivalent weight of the matter of life makes its appearance? It is true that there is no sort of parity between the properties of the components and the properties of the resultant, but neither was there in the case of the water. It is also true that what I have spoken of as the influence of pre-existing matter is something quite unintelligible; but does any one quite comprehend the *modus operandi* of an electric spark which traverses a mixture of oxygen and hydrogen? What justification is there, then, for the assumption of the existence in the living matter of a something which has no representative or correlative in the not living matter which gave rise to it? What better philosophical status has 'vitality' than 'aquosity?'"

This reasoning, on a first perusal, looks lucid and convincing; but I think a thorough examination will show that its apparent lucidity is produced by leaving out the difficulties of the question.

My reply to it.

The analogy of a watch really makes against Huxley's argument. It is true that we are "able to deduce the operations of a watch from the form of its parts, and the manner in which they are put together;" and it may be true, for anything I have to say to the contrary, that if we understood an organism as well as we understand a watch, and if we understood life as well as we understand mechanics, we should be able to deduce the properties of living beings from those of carbonic acid, water, and ammonia. But here, where Huxley takes a parallelism for granted, there is really a wide divergence; for the living matter, which is chiefly formed of combinations of

carbonic acid, water, and ammonia, has the power of organizing itself; and in order to make the parallel a valid one, the brass and steel that compose the watch ought to have the power of putting themselves together, which they have not. If, then, the case of an organism is really analogous to that of a watch, a being who understood an organism as well as we understand a watch would be able to perceive that it has been organized by a power—namely life or intelligence—which is as totally unlike the properties of the mere chemical elements as the skill of the watchmaker is unlike the properties of brass and steel.

Huxley's argument about "aquosity" is less easy to answer. But I think the suggested analogy between the effect of the electric spark in producing water out of its elements, and the effect of "pre-existing living protoplasm" in vitalizing the substances of the food, is altogether unsound. The only effect of the electric spark in the formation of water is probably to produce heat, and the effect of heat is to enable the constituents of the water to combine according to their spontaneous affinities; but when the substance of food is vitalized by the action of previously vitalized matter, or when vitalized matter assumes organic structure, I see no proof nor probability that this is due to any spontaneous tendency of matter.

THE END.

LONDON: R. CLAY, SONS, AND TAYLOR, PRINTERS.

00059863

Digitized with financial assistance from
Government of Maharashtra
on 30 January, 2020